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THIS DRAFT FINAL TECHNICAL PLAN DESCRIBES THE WORK THAT WILL BE UNDERTAKEN DURING THE PHASE I CONTAMINATION SURVEY OF SECTIONS 26 AND 35. THE OBJECTIVE OF TASK 6 IS TO OBTAIN THE GEOTECHNICAL AND GEOCHEMICAL DATA FROM EACH SITE SUFFICIENT TO ALLOW DETERMINATION OF 1) SOURCE GEOMETRY, 2) CONTAMINANTS PRESENT, AND 3) DESIGN OF THE PHASE II PROGRAM.

SECTIONS OF THIS PLAN DETAIL INFORMATION ON THE FOLLOWING:

1. SITE BACKGROUND
2. FIELD SAMPLING
3. GEOPHYSICAL INVESTIGATION
4. CHEMICAL ANALYSIS
5. QUALITY CONTROL
6. HEALTH AND SAFETY
7. DATA COMPILATION AND MANAGEMENT.

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Rocky Mountain Arsenal

Section 26 and 35 Phase I Contamination Survey

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Draft Final Technical Plan
September, 1985
Contract Number DAAK11-84-D-0016
Task Number 6 (Section 26 and 35)

PREPARED BY

ENVIRONMENTAL SCIENCE & ENGINEERING, INC.
Harding Lawson Associates   Midwest Research Institute

PREPARED FOR

U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY

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LIST OF ACRONYMS AND ABBREVIATIONS
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AA	Atomic Absorption
AR	Army Regulation
A.S.P.	Certified Photogrammetrist
CFI	Colorado Fuel and Iron Corporation
cm	centimeters
DBCP	dibromochloropropane
DCPD	dicyclopentadiene
DDT	dichlorodiphenyltrichloroethane
DIMP	diisopropylmethylphosphonate
EPA	Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
°F	degrees Fahrenheit
ft	feet
ft^2	square feet
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
HLA	Harding Lawson Associates
ICAP	Inductively coupled argon plasma
in	inches
in/yr	inches per year
mph	miles per hour
MRI	Midwest Research Institute
OSO	Onsite Safety Officer
OSHA	Occupational Safety and Health Act

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued, Page 2 of 2)

OVA	organic vapor analyzer
$PCPMSO_2$	p-chlorophenylmethylsulfone
PID	photo-ionization detector
ppb	parts-per-billion
ppm	parts-per-million
QA	Quality Assurance
QC	Quality Control
RIC	Rocky Mountain Arsenal Resource Information Center
RMA	Rocky Mountain Arsenal
Shell	Shell Chemical Company
µg/g	microgram/gram
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USGS	U.S. Geological Survey
UXO	unexploded ordnance

1.0 INTRODUCTION

1.1 DESCRIPTION OF THE RMA PROBLEM: SECTIONS 26 AND 35

The Rocky Mountain Arsenal (RMA) occupies over 17,000 acres (27 square miles) northeast of Denver, Colorado. Sections 26 and 35 are located in the northwest quadrant of the site. RMA is immediately south of the city of Henderson, Colorado and directly east of Commerce City, Colorado in western Adams County (Figure 1.1-1). The South Platte River flows parallel to the northwest boundary and is less than 2 miles from RMA. The Arsenal was established in 1942 and has been used for the manufacture of chemical and incendiary munitions as well as chemical munitions demilitarization. Industrial chemicals were manufactured at RMA from 1947 to 1982. A detailed discussion concerning the overall RMA problems is presented in the Task 1 Technical Plan.

Sections 26 and 35 contain Basins B, C, D, E, and F which were used for storage of industrial wastes and wastewater generated on RMA. Basins B, C, D, and E are unlined and were used to store the overflow from Basin A during the period from 1953 to 1957. The overflow from Basin A occurred when its capacity was exceeded as a result of wastewater from the GB facility and the South Plants facilities being discharged into the basin. Because of a civil suit which charged that Basin A was polluting the ground water, Basin F (an asphalt lined reservoir) was constructed in early 1957. Basin F received all the industrial wastes and wastewaters generated from 1957 to 1982.

In addition to the basins there are several unlined drainage ditches and chemical and sanitary sewer lines located in Sections 26 and 35. The drainage ditches transported the overflow from Basin A to the other unlined basins. The chemical sewers carried industrial wastes and wastewaters from the manufacturing facilities to Basin F, and from Basin F to the deep well disposal facility.

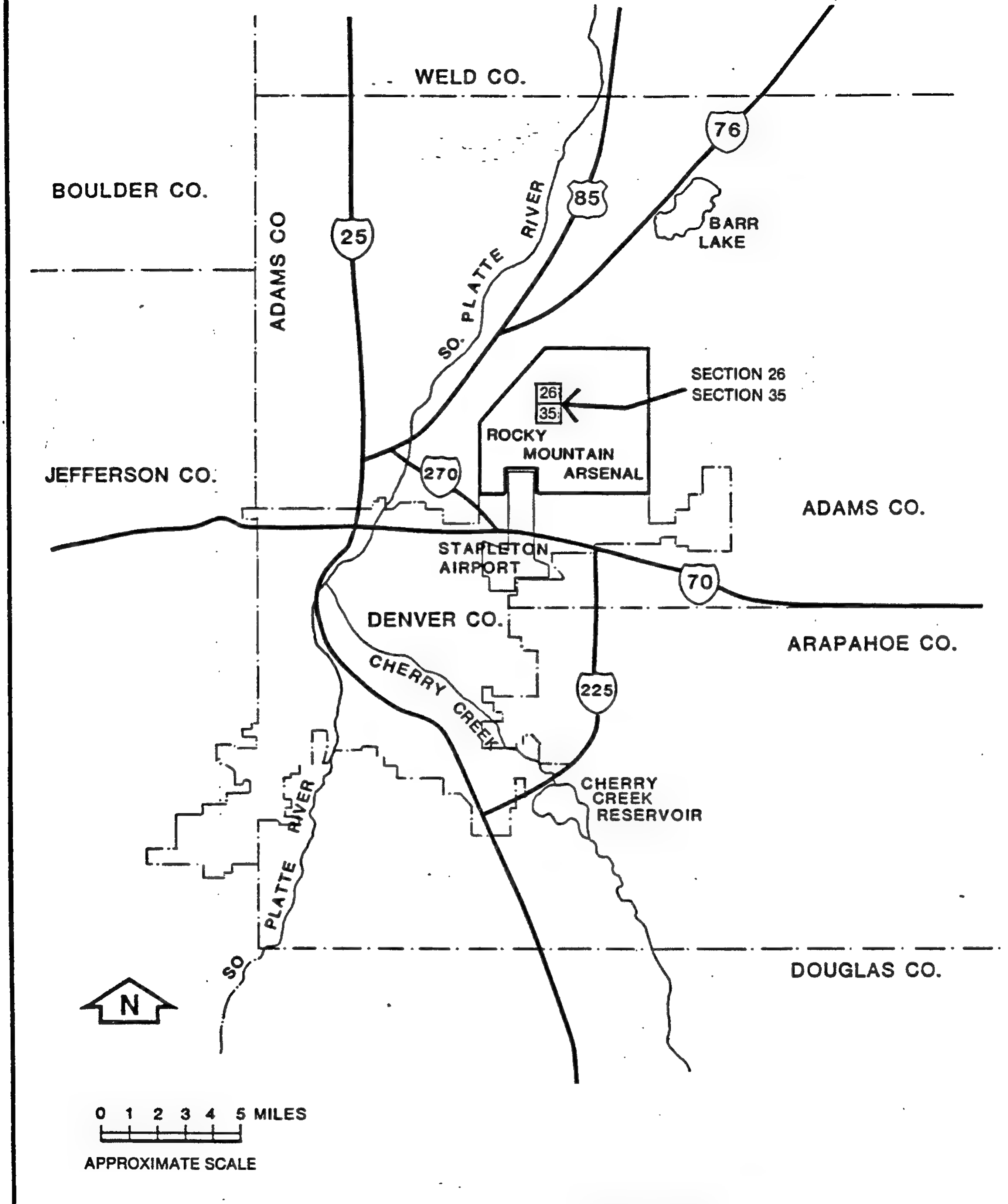

Figure 1.1-1
SITE LOCATION MAP

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U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

1.1.1 CONTAMINANT SOURCES

Previous studies and investigations performed in Sections 26 and 35 have yielded 19 specific contaminant sources. These sources are listed in Table 1.1-1. Background information concerning Sources 26-2, 26-10, 35-5, 35-8, and 35-9 has allowed U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) to classify these areas as uncontaminated for the purpose of this study. Also, based on background information for each specific source USATHAMA has decided whether specific sources are most likely the result of previous Army activities or if the specific source has high probability of being a result of Shell or joint Shell/Army activities. All the sources are shown in Figures 1.1-2 and 1.1-3. This task addresses those sources which are most likely to be the result of Shell or Shell/Army activities.

Table 1.1-1 lists all 19 original contaminant sources, disposal activities, and the status of the current investigation at each source. An intensive investigation has been postponed for Sources 26-8, 35-1, 35-6, and 35-7. USATHAMA has decided these sources will be investigated during performance of a subsequent task which is scheduled to be initiated in December 1985.

Also, as a result of USATHAMA budget constraints investigation of areas suspected of contamination not originally part of the scope-of-work for this task will be performed in a subsequent task. These sources include Sources 26-1, 26-9, 35-2, and a part of Source 36-4'. Sources 26-9 and 35-2, chemical sewer lines have been removed from Seventh Avenue to Basin F. Source 26-1, sewer lines associated with the deep well facility will be removed during the closure program. However, this technical plan presents all the background information and proposed investigation for these sources.

The investigation of Source 26-1 has been divided into two parts: (1) closure of the deep disposal well, and (2) investigation of the chemical sewers associated with the deep well. RMA personnel and/or their contractor will perform the closure activities while the chemical sewers will be investigated as part of Task 18.

Table 1.1-1. Sections 26 and 35 Contaminant Sources

Source	Source Activity	Alterations in Source Investigations
26-1	Deep Disposal Well	Chemical sewers investigated under a later task. The deep well investigated by RMA. Task 18
26-2	TX Production Area	Investigated as Uncontaminated
26-3'	Basin C	
26-4'	Basin D	
26-5	Basin E	
26-6	Basin F	
26-7	Basin B-C Drainage	
26-8	Sanitary Sewer	Task 14
26-9	Chemical Sewer	Task 14
26-10	TX Irrigation Pond	Investigated as Uncontaminated
35-1	Sanitary Sewer	Task 14
35-2'	Chemical Sewer	Task 14
35-3	Basin B	
35-4'	Basin A-B-C Drainage	Additional Area Investigation in Task 18
35-5	Ground Disturbance	Investigated as Uncontaminated
35-6	Munitions Test Area	Task 14
35-7	Firing Range	Task 14
35-8	Storage Area	Investigated as Uncontaminated
35-9	Caustic Holding Basin	Investigated as Uncontaminated

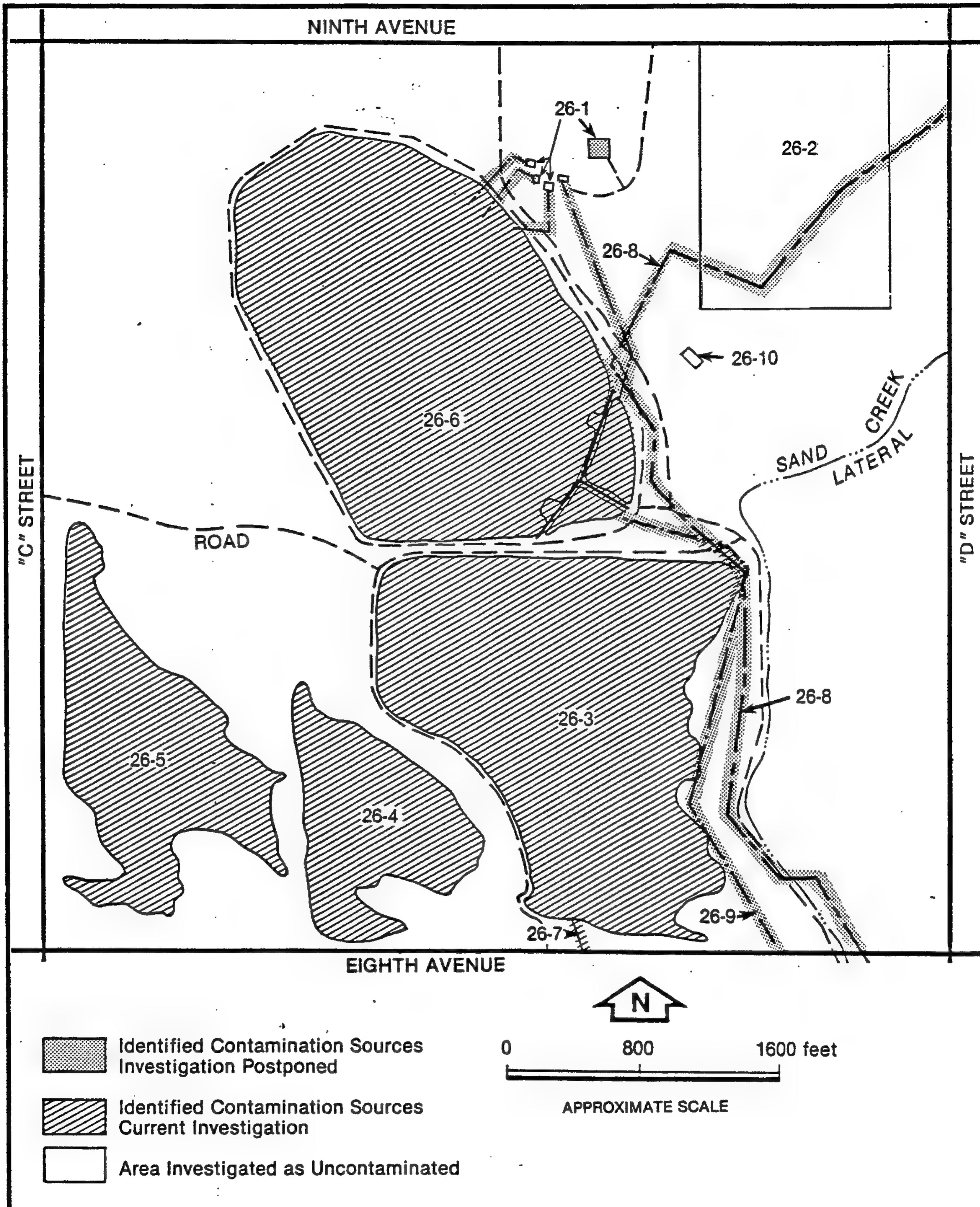

Figure 1.1-2
SITE LOCATION MAP CONTAMINATED SOURCE SITES 26-1 THROUGH 26-9
ROCKY MOUNTAIN ARSENAL, SECTION 26

SOURCE: HARDING LAWSON ASSOCIATES REVISION A, 8/9/85

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

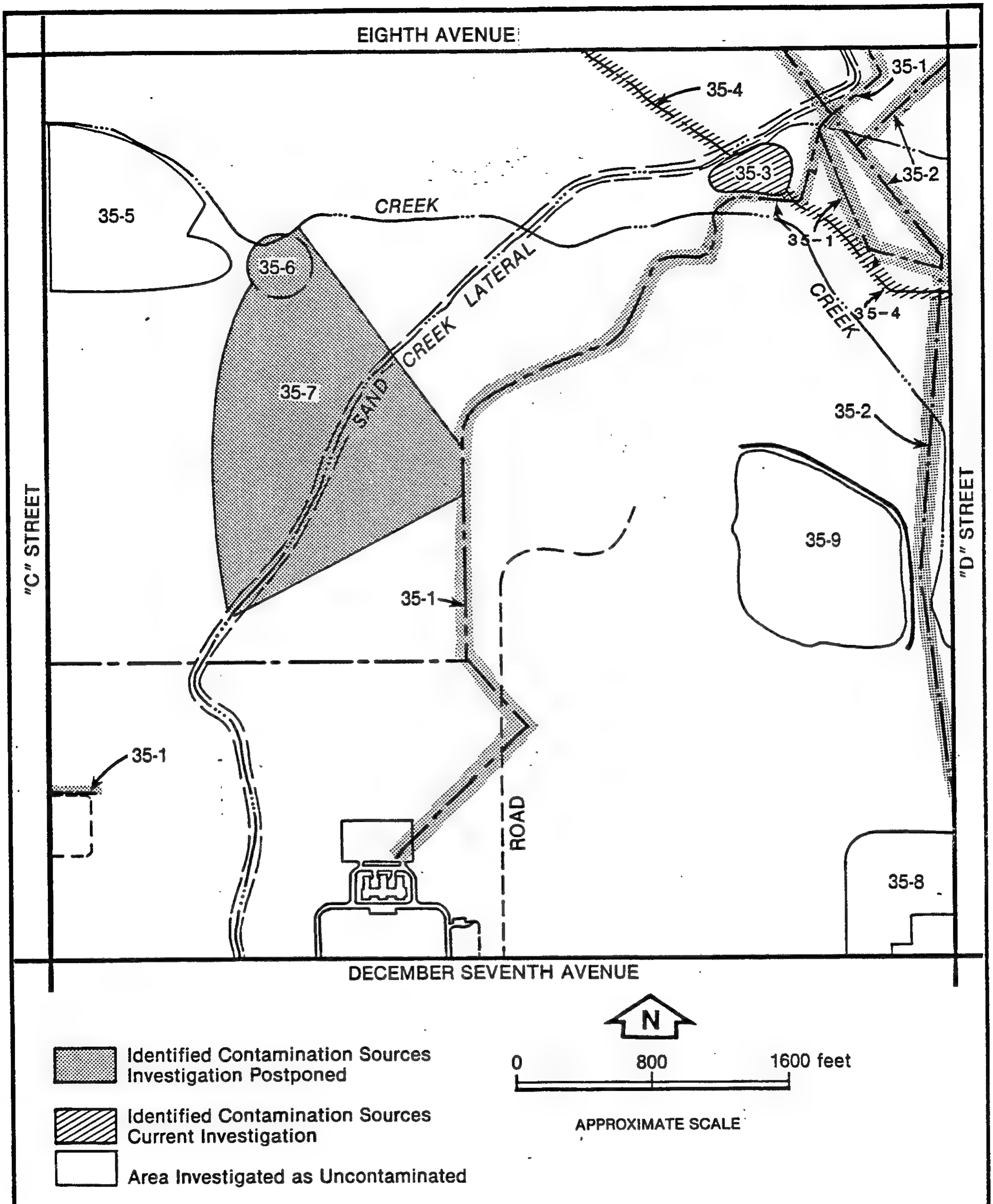

Figure 1.1-3
SITE LOCATION MAP CONTAMINATED SOURCE
SITES 35-1 THROUGH 35-9
ROCKY MOUNTAIN ARSENAL, SECTION 35
SOURCE: HARDING LAWSON ASSOCIATES REVISION A, 8/9/85

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

During preparation of this technical plan and review of associated RMA documentation, additional areas suspected of disposal activity not contained within source boundaries shown in Figures 1.1-2 and 1.1-3 were identified. The additional areas suspected of disposal activity consist of drainage ditches between basins and extensions of the chemical sewer located in Section 35 and for the most part are relatively small in size. In this case, source boundaries and their associated areal extents have been modified. Sources which have had boundary modifications are designated as follows: 26-3', 26-4', 35-2', and 35-4'.

Figures 1.1-4 and 1.1-5 are maps of Sections 26 and 35 which indicate source boundaries as they will be investigated during this program. The base map source boundaries have taken into account all program alterations summarized in Table 1.1-1. Modification of source boundaries also include additional source areas. The overlay to this figure shows all additional contaminant areas identified during preparation of this technical plan. The contaminant sources of Sections 26 and 35 to be investigated under this task can be categorized by suspected use as follows:

Source Category	Source to be Investigated
Lined/Unlined Basins	26-3', 26-4', 26-5, 26-6, 35-3
Open Drainage Ditch	26-7, 35-4'

The lined/unlined basins are Basins B, C, D, E, and F. The drainage ditches, include an extension of Source 36-8S and the main drainages from Basins A, B, and C.

1.1.2 GEOLOGY/SOILS

The geologic conditions underlying Sections 26 and 35 are relatively well defined as a result of the construction of numerous boreholes and cross sections. Many of the cross sections and boring logs are available from the Rocky Mountain Arsenal Resource Information Center (RIC).

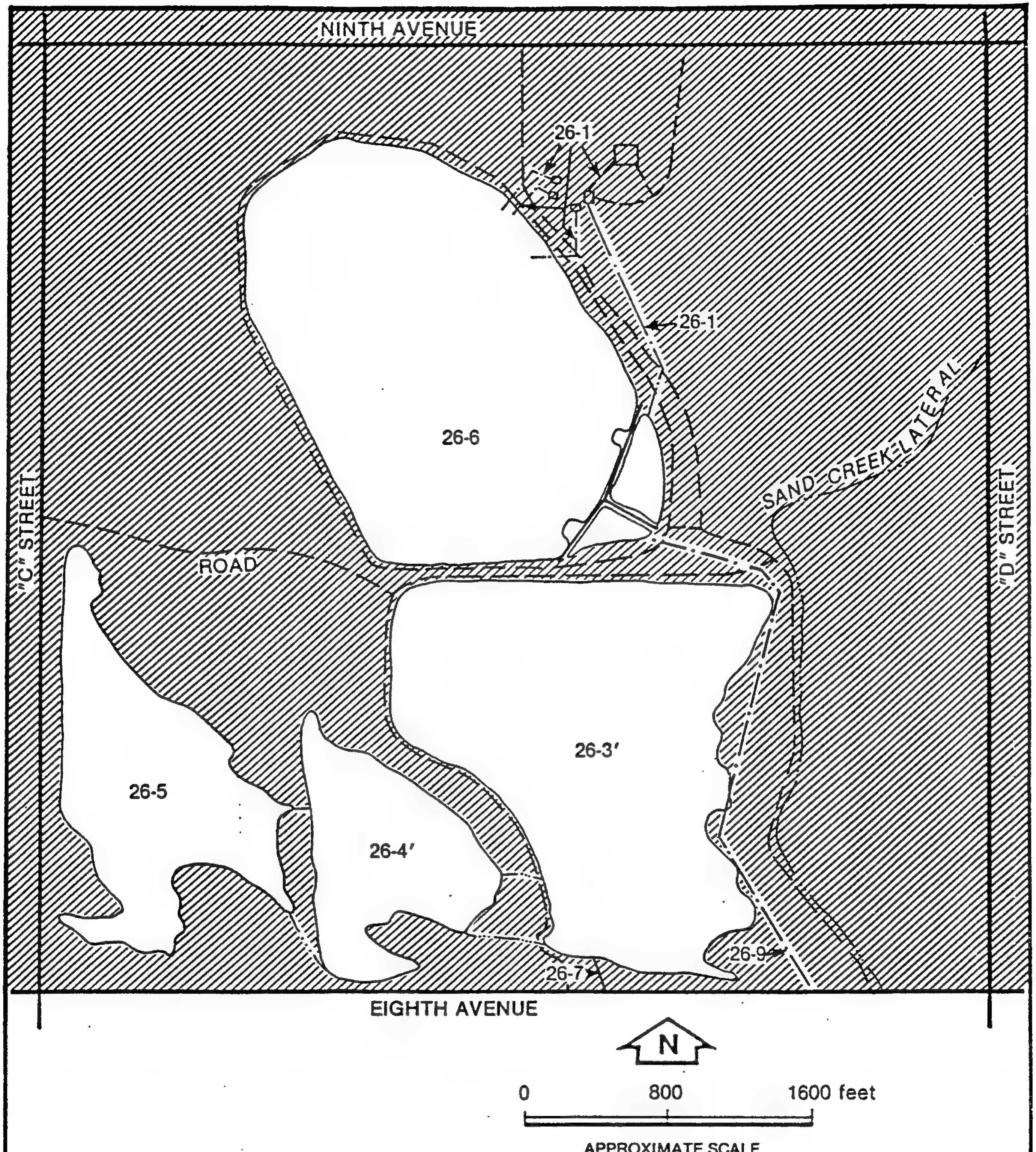

Figure 1.1-4
REVISED LOCATION MAP
SHELL OR SHELL/ARMY SOURCE
SITES 26-3' THROUGH 26-12'
ROCKY MOUNTAIN ARSENAL, SECTION 26
SOURCE: HARDING LAWSON ASSOCIATES

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

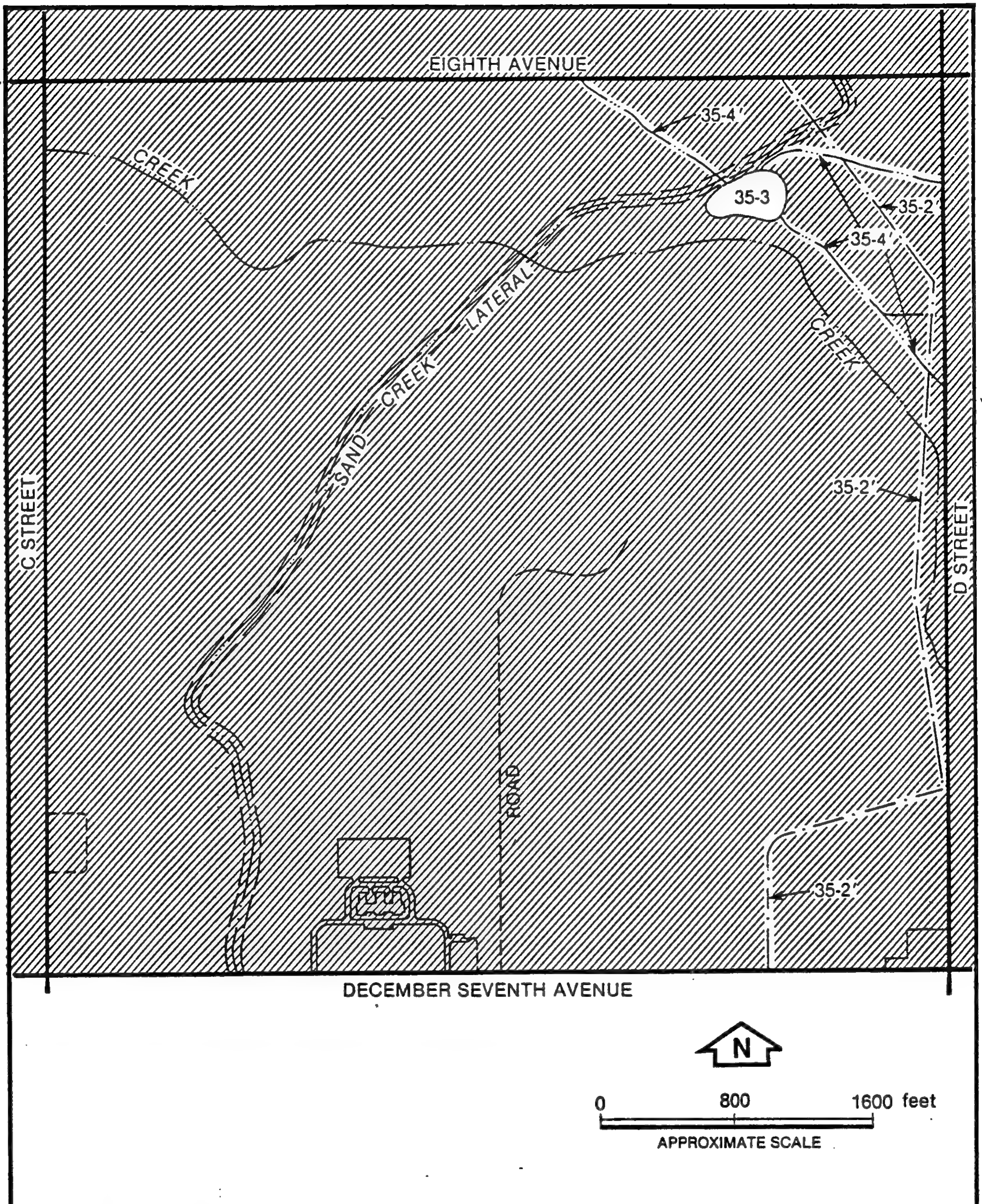

Figure 1.1-5
REVISED SITE LOCATION MAP
SHELL OR SHELL/ARMY SOURCE
SITES 35-2' THROUGH 35-12'
ROCKY MOUNTAIN ARSENAL, SECTION 35
SOURCE: HARDING LAWSON ASSOCIATES

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U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

The surficial geology consists of alluvial material over most of Sections 26 and 35. The alluvial deposits consist of interbedded silty clay, silt, sand, and gravel. In most areas the alluvium is covered by wind-blown silt. In Section 26 the thickness of the alluvium varies from 10 to 50 ft with thickest alluvium beneath Basin F. The alluvium varies in thickness from 20 to 40 ft in Section 35.

The soils present in Section 26 consist of the following major soil types; Ascalon sandy loams, Platner clay loams, Truckton loamy sands, and Weld loams. The predominant soil types are the Ascalon sand loams and the Truckton loamy sands.

Section 35 soils are predominantely the Ascalon sandy loams and the Truckton loamy sands. A small outcropping of the Denver Formation (clay-shale) is located in the center of Section 35.

The Ascalon sand loam soils are formed on well drained, nearly level to moderately sloping surfaces. They are brown sand loams which become progressively more clacareous with depth. They absorb water at moderate to rapid rate, and permeabilities are moderate.

Platner clay loams form on old alluvium surfaces that are level to gently sloping. They are comprised of grayish-brown clays and clay loams to depths of 30 inches (in). Below this depth the color is paler and the soils become sandy and more calcareous. This soils absorbs water slowly, and its permeability is low.

Truckton sandy loams are formed on well drained gently to strongly sloping surfaces. The soils absorb water at a moderate to rapid rate and permeabilities are moderate to rapid. The erosion hazard of these soils is moderate to severe.

Weld loams are found on well drained very gently sloping surfaces. These soils absorb water at a moderate rate and permeabilities are slow to moderate. Erosion hazard is moderate.

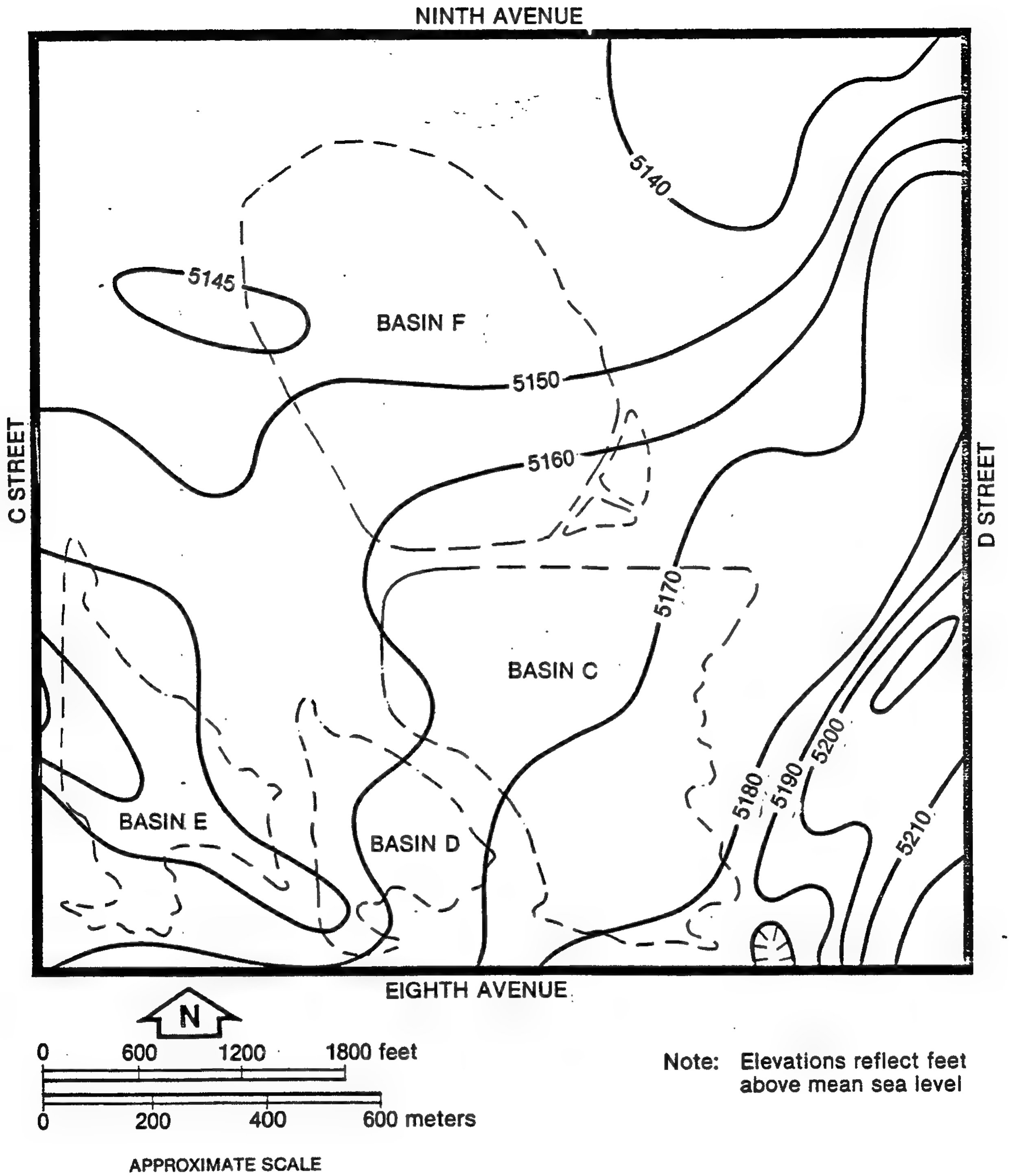


Figure 1.1-6
ELEVATION OF THE DENVER FORMATION;
ROCKY MOUNTAIN ARSENAL, SECTION 26

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

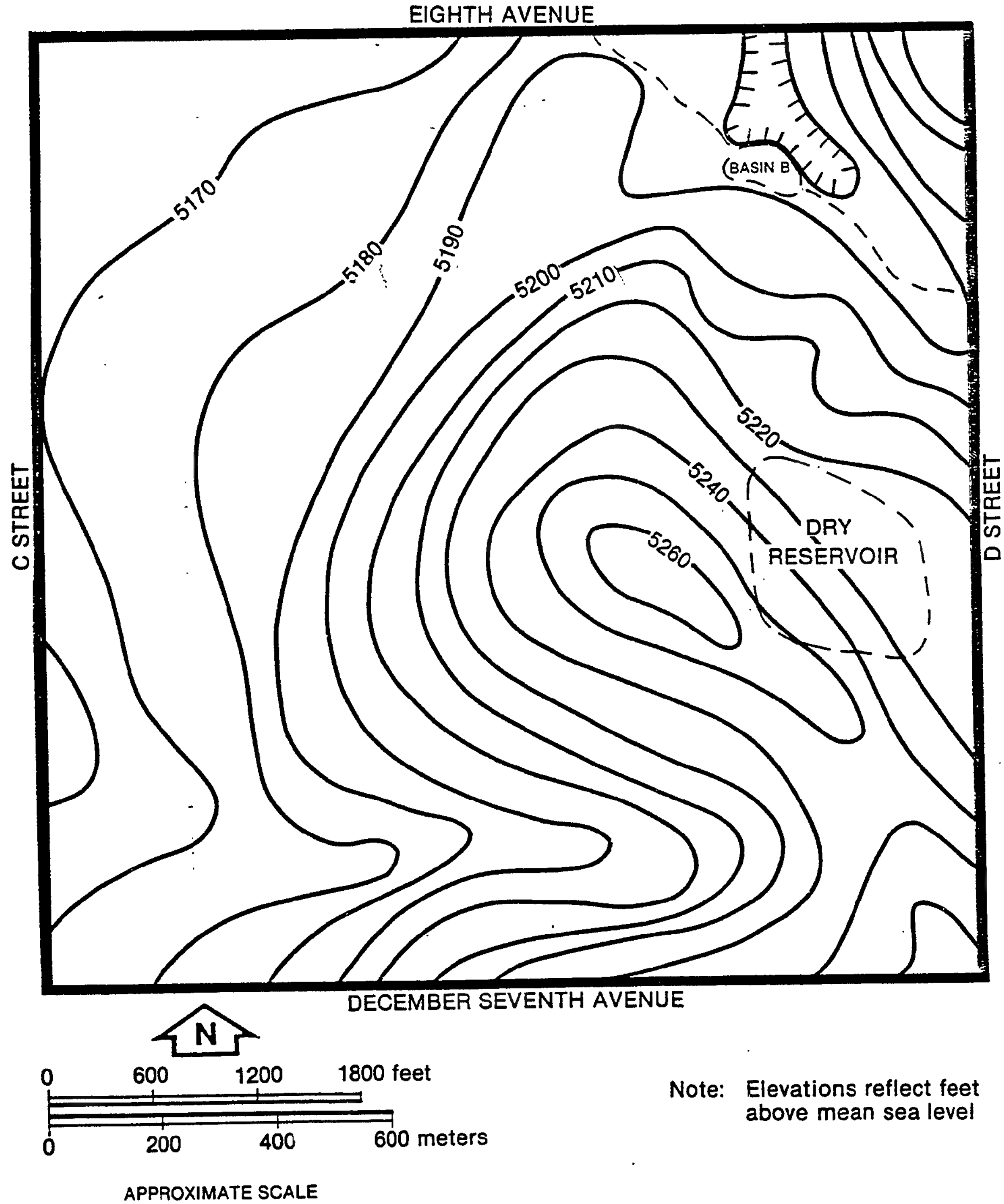


Figure 1.1-7
ELEVATION OF THE DENVER FORMATION;
ROCKY MOUNTAIN ARSENAL, SECTION 35

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

Beneath the alluvium lies the Denver Formation. Structural contour maps of the top of the Denver Formation for Sections 26 and 35 are presented as Figures 1.1-6 and 1.1-7. The Denver Formation is a cyclic deltaic deposit consisting of interbedded silt, clay, and sandy units. The interpretation of the contact between the alluvial material and Denver Formation has changed during the course of RMA investigations based on differing classification of core samples. Not all geologic maps and cross sections are consistent. The upper portions of the Denver contain volcanoclastics, a thick sequence of clay shale with interbedded lenses of clay, sand, and lignite. Additionally, channel-sand deposits also occur. The lower portion Denver contain a discontinuous lignite seam, a semi-continuous sand unit, a clay shale, and channel-sand deposits. Beneath RMA the Denver Formation ranges in thickness from 240 to 450 ft.

1.1.3 HYDROGEOLOGY AND GROUND WATER QUALITY

Shallow ground water beneath Sections 26 and 35 is contained in the two geologic units discussed in Section 1.1.2. The alluvial aquifer is unconfined while the Denver Formation aquifer is considered to be semi-confined in the upper zones and confined in the lower zones. Faults may be providing a hydraulic connection between the alluvial and Denver aquifers. However, May 1982 states that aquifer pumping tests do not show that these faults significantly affect the local ground water flow regime. Ground water contour maps for Sections 26 and 35 are presented in Figures 1.1-8 and 1.1-9.

1.1.4 SURFACE WATER HYDROLOGY AND WATER QUALITY

Surface water features within Sections 26 and 35 include the following:

- o Basins B (35-3), C (26-3'), D (26-4'), E (26-5), F (26-6) and the caustic holding basin (35-9).
- o The Sand Creek lateral which carries runoff from the South Plants area in a northeasterly direction across Section 35 and up the eastern third of Section 26.

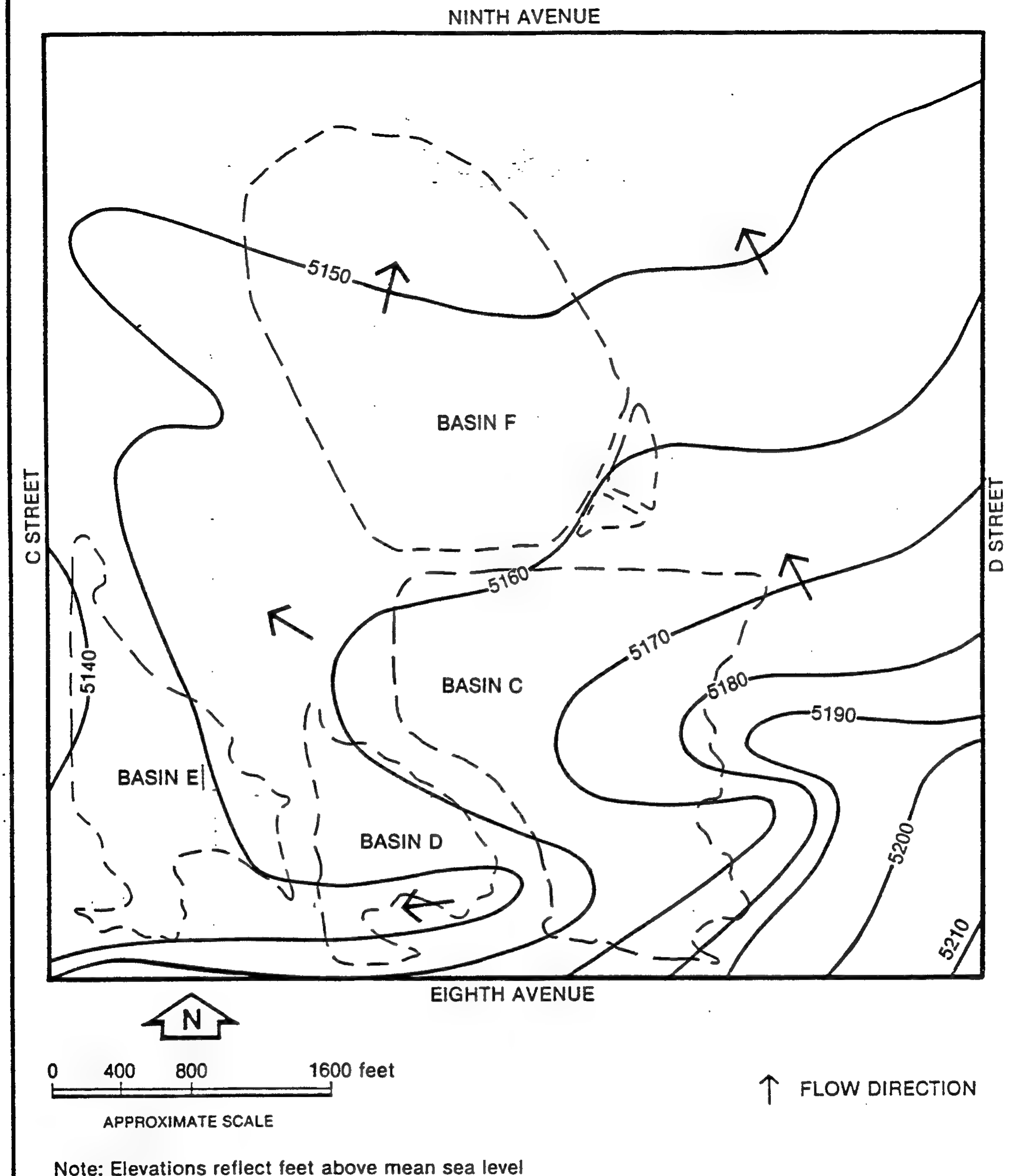
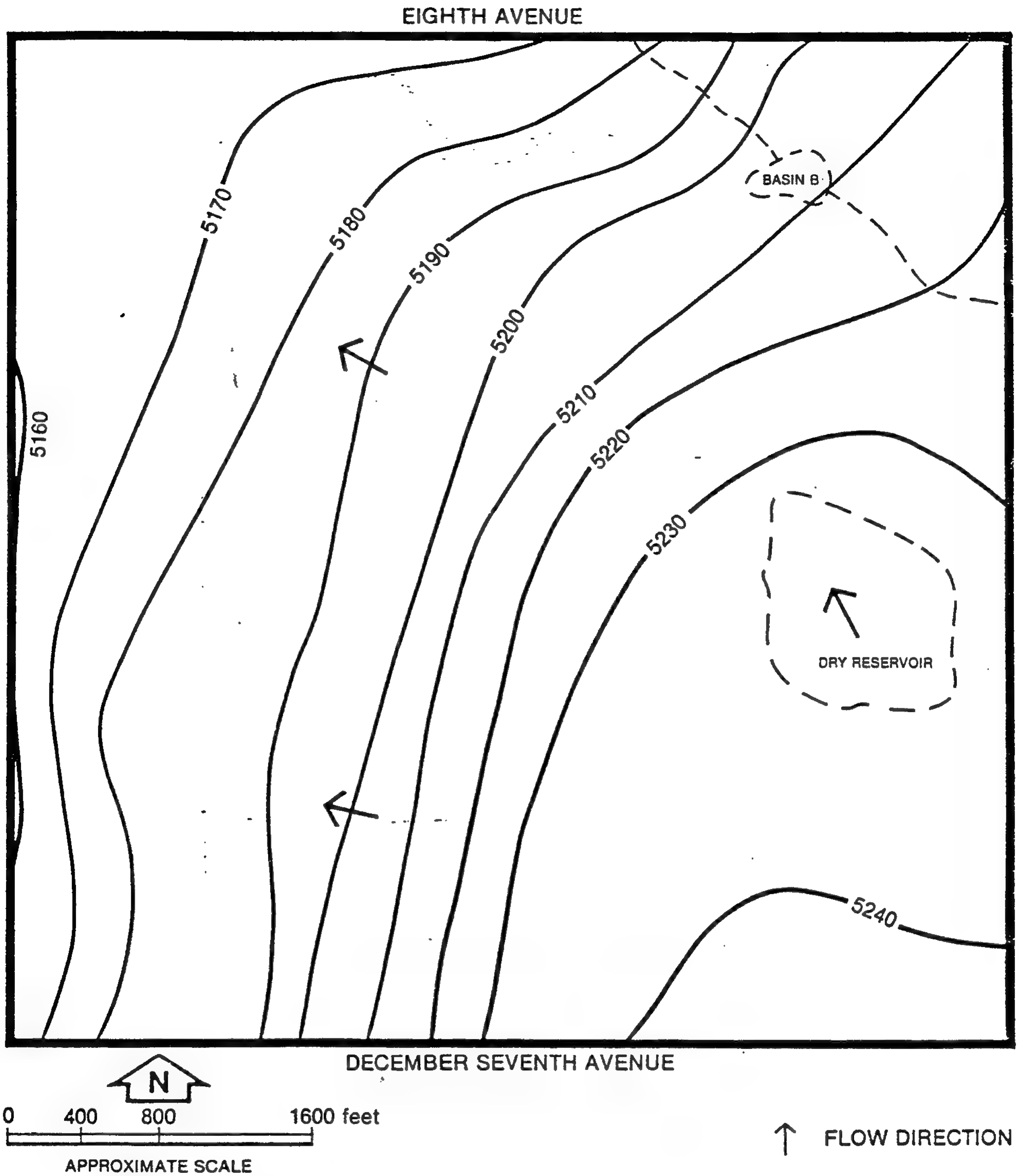


Figure 1.1-8
GROUND WATER CONTOUR MAP;
ROCKY MOUNTAIN ARSENAL, SECTION 26

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland



Note: Elevations reflect feet above mean sea level

Figure 1.1-9
GROUND WATER CONTOUR MAP;
ROCKY MOUNTAIN ARSENAL, SECTION 35

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Aberdeen Proving Ground, Maryland

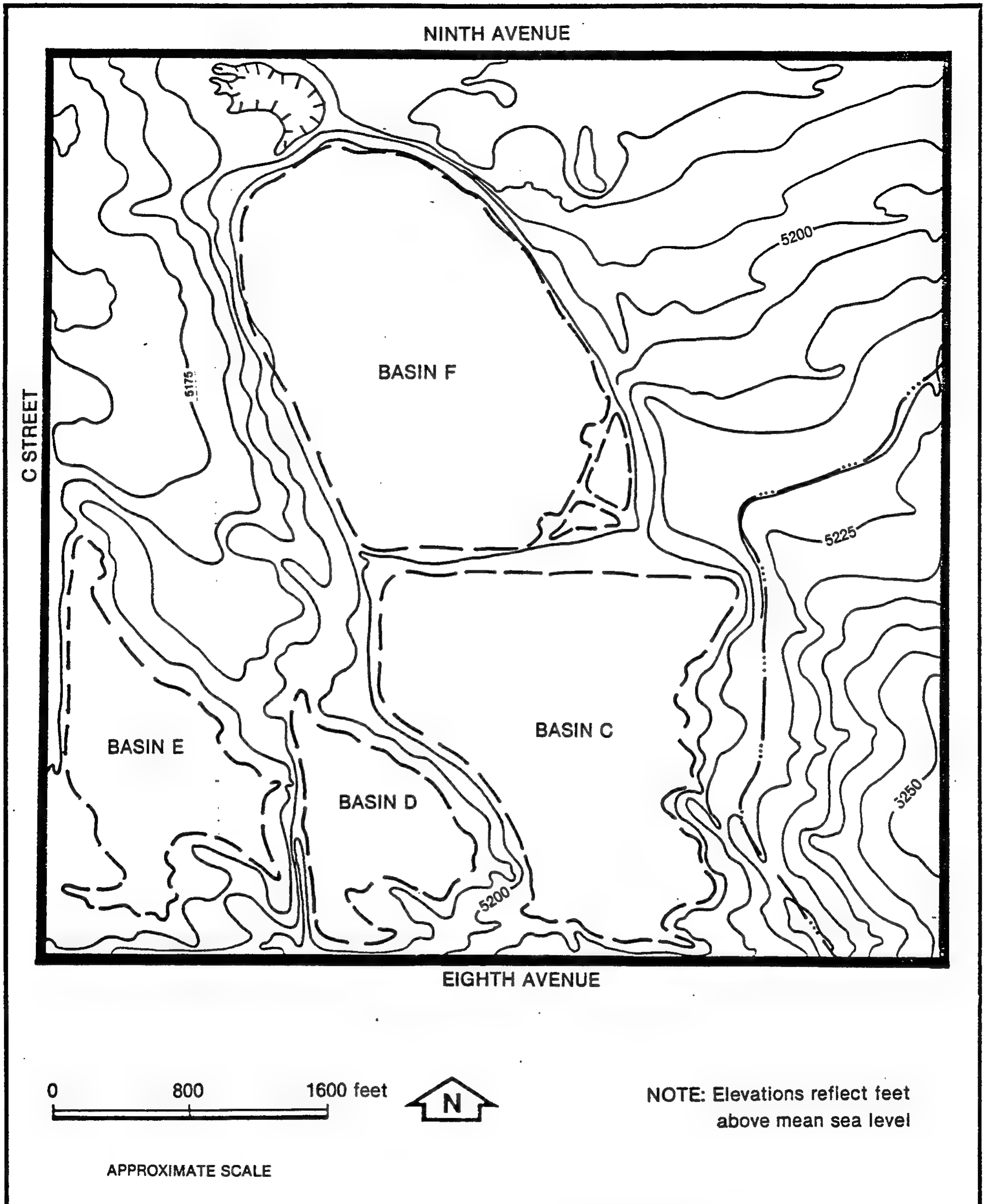

Figure 1.1-10
TOPOGRAPHIC MAP;
ROCKY MOUNTAIN ARSENAL, SECTION 26

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Aberdeen Proving Ground, Maryland

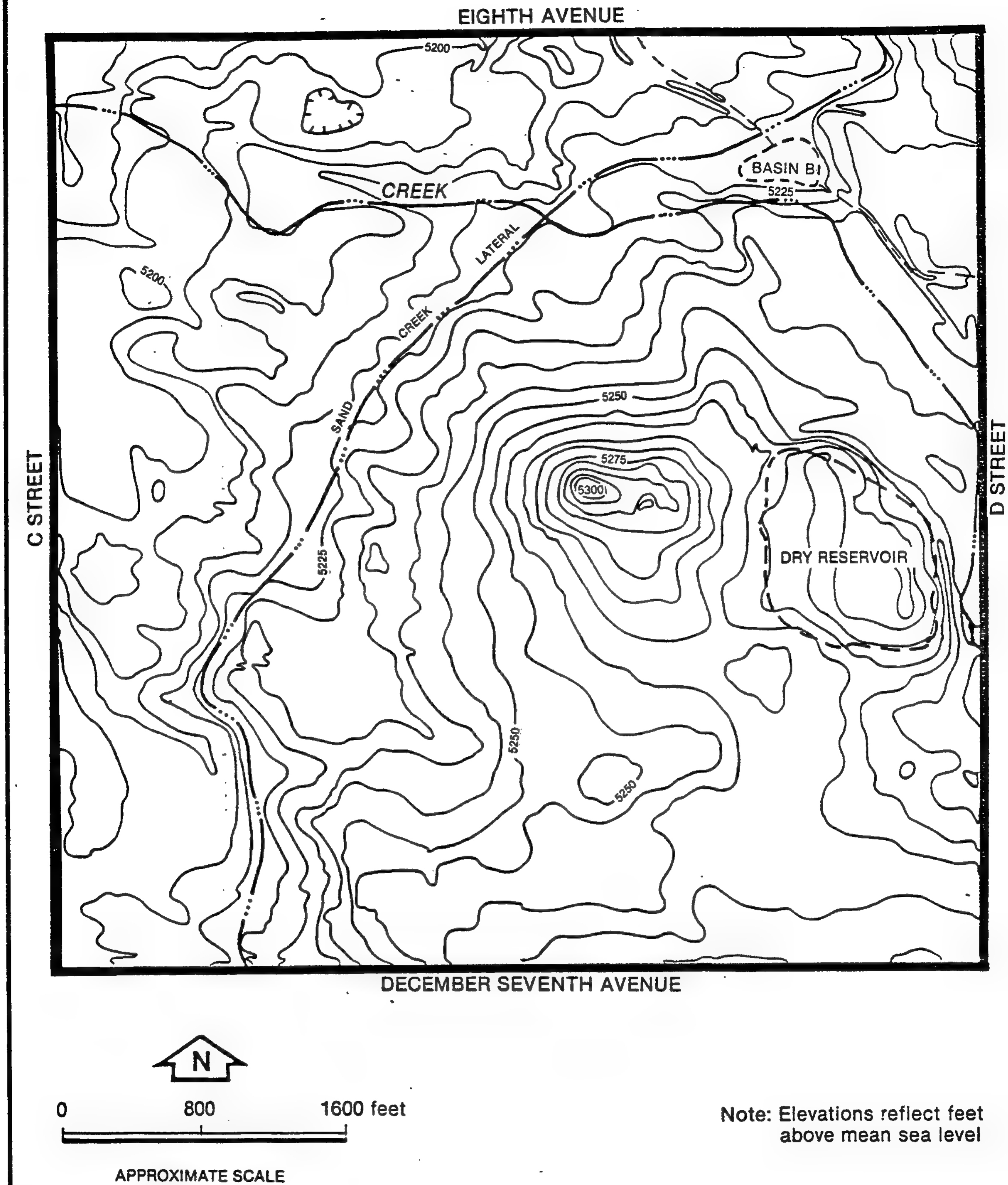


Figure 1.1-11 TOPOGRAPHIC MAP; ROCKY MOUNTAIN ARSENAL, SECTION 35	**Prepared for:** **U.S. Army Toxic and Hazardous Materials Agency** **Aberdeen Proving Ground, Maryland**

- o Several drainage ditches that are extensions of drainages from Section 36. These include Source 35-4', and an extension of Source 36-8S which transverses Section 35 from east to west. Ditch Source 35-4' carried fluids from the Basin A neck area to Basins B and C.

Topographic maps of Sections 26 and 35 are presented as Figures 1.1-10 and 1.1-11. These maps indicate the direction of surface water flow for both sections. Evaporation and infiltration keep the unlined basins relatively dry during late spring and summer. At the time of the site reconnaissance (June 1985), there were two distinct areas of ponding in Basin F (a lined reservoir). The ponded liquid appeared to be mixtures of rainfall and residual waste materials.

1.1.5 CLIMATIC CONDITIONS

The RMA area is generally classified as mid-latitude semi-arid. This indicates an area with hot summers, cold winters, and relatively light rainfall. Mean maximum temperatures range from 43 degrees Fahrenheit (°F) in January to 88°F in July. The mean minimum temperatures are 16°F in January and 59°F in July. Precipitation in the general region is approximately 12 to 16 inches per year (in/yr) with approximately 80 percent falling between April 1 and September 30. Snow and sleet usually occur from September to May with the heaviest snowfall in March and possible trace accumulations as late as June. Thunderstorms occur frequently in the region. They are generally accompanied by heavy showers, severe gusty winds, and frequent thunder and lightning with occasional hail. There are approximately 93.1 days per year with a cloud cover of 30 percent or less. Early morning inversions over the Denver Metropolitan Area are common, but they rarely persist through the day. This prevents mixing and causes accumulation of pollutants.

The prevailing winds at RMA are from the south and south-southwest, paralleling the foothills west of Denver. Occasional winds are also out of the north-northwest, north, and east. Wind speeds average about 9 miles per hour (mph) annually. The windy months are March and April,

with gusts as high as 65 mph. These months come immediately after the driest months of the year (November through February) and have the highest potential for dust storms.

The Denver Metropolitan Area has experienced chronic air quality problems in recent years. During stagnant and/or inversion conditions, ozone and carbon monoxide concentrations sometimes create extremely poor air quality. This problem has generally been associated with motor vehicles, and the area impacted includes RMA.

RMA's potential influence on air quality includes wind-borne migration of contaminant-bearing particulates from dry waste basins and volatile organic emissions from Basin F. Because of these concerns, the U.S. Army Environmental Hygiene Agency (USAEHA) was requested to examine potential air quality problems and recommend appropriate precautions. A suspended particulate study of the dry basins was conducted in 1981 by USAEHA to evaluate the health hazard posed by low levels of fugitive dust. The contaminants studied were arsenic, mercury, cadmium, copper, lead, aldrin, dieldrin, and endrin. Concentrations of the various contaminants monitored in the fugitive dust were considered not to pose a significant hazard to members of the general population around RMA or to individuals occupationally exposed to wind-blown dust emanating from disposal basins at RMA. An additional study to determine the impact of volatile organic emissions from Basin F was completed. The study concluded that operation of the enhanced evaporation system at Basin F will not affect the overall lifetime cancer risk to the general population (DAR)*. Future air monitoring will be conducted under Task 17.

1.1.6 BIOTA

A significant portion of Section 26 and to a lesser degree Section 35 have been disturbed by disposal activities. Specifically these areas include Basins B, C, D, E, and F and several man-made drainage ditches and sewer systems which traverse Sections 26 and 35. A vegetation and animal life study was performed by Kolmer and Anderson (1977) which describes the primary vegetation as successional. This denotes recently disturbed material with dominant species being wheatgrass, prickly

* DAR - Priviledged Litigation Information

lettuce, and western ragweed. The central portion of Section 35 is termed mid- to late-successional with dominant species including sand dropseed, red threeawn, crested wheatgrass, and blue grama. This study also summarized preliminary biological work by listing invertebrates, amphibians, reptiles, birds, and mammals which frequent this habitat. Future biota studies will be conducted under Task 9.

1.2 SUMMARY OF TECHNICAL APPROACH

The primary purpose of this Phase I investigation for Sections 26 and 35 is to obtain geotechnical and geochemical data that will be used to evaluate contaminant liability and design a Draft Phase II Quantitative Investigations Program. To accomplish this objective, specific geochemical data must be compiled and evaluated for each contaminant source. This data must include determination of:

- Contaminants present;
- Lateral extent of contamination;
- Vertical extent of contamination;
- Source geometry;
- Source homogeneity; and
- Origin of specific contaminants.

To collect these data the project team will perform numerous soil borings within Sections 26 and 35, collect soil samples, submit these samples for chemical analysis, and interpret the resulting data. To achieve maximum program efficiency the investigation has been separated into Phase I and Phase II. Task 6 will contain only the Phase I investigation. Phase II will be performed under a subsequent task order.

The objective of Task 6 is to obtain the semi-quantitative chemical data from each source sufficient to allow determination of approximate source geometry, contaminant compounds present, source responsibility and supply sufficient information to later design a Phase II program (Task 18). Phase I will use gas chromatography/mass spectrometry (GC/MS) and metal screening procedures to identify the types of compounds present at each source and the approximate areal and vertical extent of contamination. Phase I will also investigate all uncontaminated and background areas of Sections 26

and 35 with a sufficient number of samples analyzed to ensure with a reasonable degree of certainty these areas are in fact uncontaminated. During Task 6 borings will be constructed at each source. Twenty percent of these borings will be constructed to the water table. At sources where disposal or containment of liquids has occurred, the Phase I investigation will halt at the point of water table contact. Soils collected from all Phase I borings will be submitted to the laboratory for semi-quantitative scanning and select quantitative analyses for the same list of potential organic and inorganic contaminants as performed in Task 1.

Prior to any sample collection all obtainable and relevant background data will be compiled and evaluated. Much of this subtask has been performed during preparation of this Technical Plan.

The support facility constructed for the Task 1 (Section 36) investigation will provide the project team with personnel and equipment decontamination services. This support facility will also be used for project team office space, materials storage, and working area.

Establishment of a coordinate system for Sections 26 and 35 will be performed in order to determine exact locations of disposal sources.

Limited geophysical methods as determined appropriate by the Task 1 investigation will be used to determine if buried objects may be present at drill site locations. Soil sampling will be performed as described in Section 3.4 of this Technical Plan at locations specified in Section 3.3.

2.0 EVALUATION OF BACKGROUND DATA

2.1 DATA COMPILATION

The project team expects that, although a considerable effort has been made to review site specific background information for the Task 6 (Sections 26 and 35) investigation that the gathering of pertinent data will be an ongoing process. A constant review of background data will be performed throughout the duration of the project.

2.1.1 INITIAL SITE RECONNAISSANCE

On June 7, 1985 several personnel from Harding Lawson Associates (HLA) and Environmental Science and Engineering, Inc. (ESE) performed a site reconnaissance of Sections 26 and 35. The purpose of the site reconnaissance was to validate mapped locations of contaminant sources, examine the spacial and physical relationship of known sources, and to identify additional potential sources. During the course of the site reconnaissance all deviations from the RMA Contaminant Source maps were noted.

For the most part areal extents of Basins B through F were found to be correctly mapped. However, several drainage ditches connecting these basins were not included in the confines of the respective basins. These areas have been subsequently added to the investigation.

2.1.2 LITERATURE REVIEW

The project team, during preparation of this Technical Plan has reviewed a number of documents detailing the location of Sections 26 and 35 sources, their probable disposal history, and approximate areal extent. A bibliography of these references can be found in this plan. Particular attention has been paid to chemical compounds and hazards expected to be encountered at source sites.

2.2 SECTION 26 AND 35: CONTAMINANT SOURCES

Within these two sections at least 19 discrete potential contaminant sources have been identified. These sources were identified primarily by examination of aerial photographs and review of existing background

documents. These sources include a lined basin (Basin F), unlined basins, surface water drainages, chemical sewers, and open chemical drainages. Specific details for each source can be found in Section 3.3.1 of this Technical Plan.

3.0 GEOTECHNICAL PROGRAM

The primary purpose of the Task 6 geotechnical investigation is to identify contaminant compounds present and define the areal and vertical extent of contamination by performing a Phase I investigation in Sections 26 and 35. A list of the sources to be investigated and probable disposal use is presented as Table 1.1-1. Source locations are shown in Figures 1.1-4 and 1.1-5. The purpose of Task 6 is to obtain Phase I semi-quantitative geotechnical and geochemical data which will provide a preliminary assessment of the extent of the contaminated zones and also information on the chemical compounds present at each source. Task 6 data will be provided as information for determination of Shell liability at the first hearing scheduled for January 1986. The Task 6 data will be used to develop the sampling program for Phase II. All drilling procedures, sample collection, sample preservation and handling procedures, as well as data recording procedures will be in accordance with USATHAMA Geotechnical Requirements (USATHAMA, 1983) as detailed in the Task 1 Technical Plan.

3.1 ESTABLISHMENT OF COORDINATE SYSTEM

To facilitate location of sources and boring sites for the geotechnical program a coordinate system will be established for Sections 26 and 35. This system will consist of a network of coordinate points located on 1,000 ft centers that can interface with the current USATHAMA data base. The points will be marked with 4 ft long wooden 4 by 4's placed firmly in the ground. Each point will be assigned a unique number using a system which is clearly distinct from that used for numbering the borings. Each reference number will be stamped on a metal tag affixed to its corresponding stake. After all the points are staked and numbered, their map coordinates and ground-surface elevations will be determined by a surveyor registered in the State of Colorado. The data will be compiled in tabular form and will include for each point, the reference number, the map coordinates, the ground surface elevation, and the measurement date. The reference data will be clearly stated. In addition the lots formed by the coordinate system will each be assigned a unique number.

Horizontal and vertical surveys will be established within the site to control the mapping and to provide locations for geotechnical investigations. Horizontal control will be based on the Colorado State Plane Coordinate North Zone and vertical control will be based on Mean Sea Level of 1929.

Basic horizontal control for mapping will consist of electronic traverses originating and closing on stations of the U.S. Geological Survey (USGS) or National Geodetic Survey and conforming to second order standards of accuracy. Ties will be made from traverse stations to any apparent section corners or quarter corners found in Sections 26 and 35.

Vertical control will consist of elevations determined by spirit leveling to third order standards of accuracy. Elevation will be established for traverse stations or other suitable semi-permanent points as well as for the photo identities required for mapping.

Control for the geotechnical investigations will consist of coordinates and elevations determined for the 1,000 ft grid of points marked by wooden stakes. This network will be rayed in from the traverse stations using the HP3820 or equivalent theodolite/EDM, to conform to plus or minus 2 ft accuracy.

All surveys will be performed under the directions of a Land Surveyor registered in the State of Colorado. As weather conditions permit, black and white aerial photography will be obtained of the project area at a nominal negative scale of 1 in equals 425 ft using a Wild RC-10 or equivalent precision mapping camera equipped with a high resolution-low distortion lens.

Aerial negatives will conform to accepted mapping specifications for scale, overlap, density, and image quality. Utilizing the aerial photography and ground control described above, orthophoto base maps with superimposed contours will be prepared.

Orthophoto negatives will be prepared directly at the final scale of 1 in equals 200 ft, and contours will be plotted at 2 ft intervals with spot elevations shown to the nearest tenth of a ft where the contours are more than 4 in apart at map scale.

All work will be performed under the direction of a Certified Photogrammetrist (A.S.P.) and will conform to National Map Accuracy Specifications. Maps generated by this task will be used to locate contaminant sources and borehole locations.

3.2 SURFACE GEOPHYSICS

Review of existing background data for Sections 26 and 35 have not resulted in identification of any information that suggests buried metal debris or unexploded ordnance (UXO) exist at the sources to be investigated under Task 6. However, Sources 35-6 (Munitions Test Ranges) and 35-7 (Firing Range), which will not be investigated under Task 6, have uncertain areal extents. In addition, several drums were observed in Basin C (Source 26-3). Although an extensive geophysical program is unnecessary for the Task 6 investigation, a method of locating buried metal objects in the immediate vicinity of a proposed borehole is necessary. Therefore, a minimal geophysical program is proposed with provisions to upgrade the investigation as appropriate.

The primary objective of the Task 6 geophysical program is to locate buried metal objects at proposed borehole locations. This will be accomplished by use of a metal detector which the Geophysical Test Program performed in Task 1 estimated was effective to depths of 2 ft. An area approximately 20 ft in diameter surrounding the borehole will be screened and the borehole location moved if necessary. If use of the metal detector results in the location of significant metallic debris in Sections 26 and 35 source areas then the geophysical program in that source will be upgraded to include use of the gradiometer methods employed in Section 36 (Task 1).

The proposed geophysical program in areas where significant metal debris may be found would include the set up of a 20 ft square grid and

gradiometer transects run on 5 ft intervals. Following collection and compilation of data an IBM PC will be used to present gamma contours. The metal detector will then be utilized to discern if metal is at a depth of 2-5 ft or near surface (0-2 ft). The borehole location will be moved following interpretation of the generated geophysical data. All geophysical methods are described in detail in the Task 1 Technical Plan.

3.3 BORING PROGRAM STRATEGY

In order to designate an adequate number of borings to small sources areas and prevent large source areas from containing the majority of boring locations, a single grid spacing could not be selected for all contaminant sources. Therefore a method for determining tighter boring spacings for small sources and wider boring spacings for large areas was devised. This method is based upon prior experience at contaminated sites, best professional judgement, and the following characteristics of each specific source:

- o Estimated areal extent of contamination.
- o Suspected contaminant compounds.
- o Past disposal practices.

Upon consideration of the above factors Figure 3.3-1 was generated. This curve represents selected boring spacing for the total (Phase I and II) program as a function of the areal extent of contaminant sources. With an estimated areal extent for a specific source the boring spacing was selected and rounded to the nearest 10 ft interval. For example, a contaminant source whose areal extent is 250,000 ft^2 yields a boring spacing of approximately 88 ft, which is rounded to 90 ft. This would result in 31 borings for this source. Phase I and Phase II borings will be arranged for each source in a uniform grid pattern to aid in statistical interpretation following completion of each phase.

All non-linear sources in Sections 26 and 35 were exposed to fluids of variable and complex composition and therefore all of these sources are considered complex. However, approximately 50 percent of the areal extent of Basin F is either not accessible or covered by water and cannot be sampled. The quantity of existing available information for Basin F

has resulted in a downgrading of the investigative boring spacing as calculated from Figure 3.3-1. The boring spacing for Basin F as determined by Figure 3.3-1, was multiplied by a factor of 1.25 and rounded to 190 ft.

Once the total number of Phase I and Phase II borings was calculated for these non-linear sources this number was multiplied by 30 percent for sources less than 1,000,000 ft^2 and 25 percent for sources in excess of 1,000,000 ft^2 for construction during Task 6 (Phase I). The remaining boreholes will be constructed during a subsequent task.

For linear sources such as drainage ditches and sewers a different approach has been taken as these are line-sources. Line sources which have contained contaminated fluids or have a high likelihood of containing such fluids Task 6 investigation will construct borings at 500 ft spacing for the length of the source. An example of this type of source is the drainage ditches between Basins A, B, C, D, and E.

In general, 20 percent of all Phase I borings within a source area will be constructed to the water table. These deep borings will be located near the center of sources and will not go beyond the water table to reduce the potential for inducing ground water contamination. The remaining 80 percent of Phase I borings will be constructed to shallower depths within the unsaturated zone.

Large portions of RMA are considered to be uncontaminated, however, some of these uncontaminated areas are adjacent to known sources while other uncontaminated areas are far from contaminant source boundaries. To provide adequate data to confirm areas adjacent to known sources are in fact uncontaminated and to provide background information on large uncontaminated areas the following strategy was devised. Boring spacings for uncontaminated areas are selected as 500 ft, 750 ft, or 1,000 ft dependent upon historical information. For uncontaminated areas which are located in sections having a high percentage of contaminated area (Section 36) a boring spacing of 500 ft will be selected. For sections having a moderate percentage of contaminated areas a boring spacing of

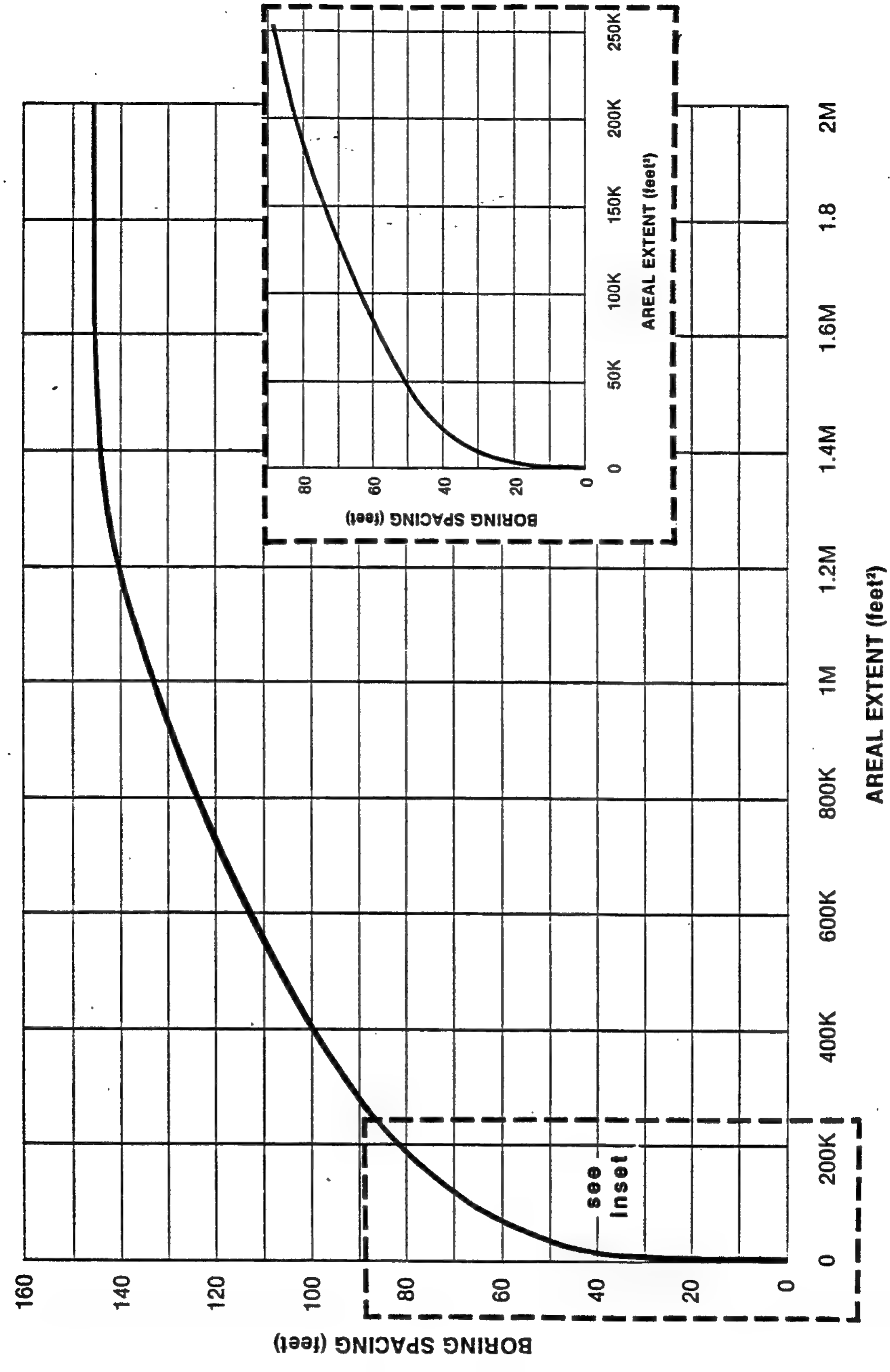


Figure 3.3-1

BORING SPACINGS FOR CONTAMINANT SOURCES BASED ON AREAL EXTENT ROCKY MOUNTAIN ARSENAL, SECTIONS 35 & 26

SOURCE: HARDING LAWSON ASSOCIATES

Prepared for:

U.S. Army Toxic and Hazardous Materials Agency

Aberdeen Proving Ground, Maryland

750 ft will be selected. For RMA sections which contain few or no known contaminant sources a boring spacing of 1,000 ft will be selected. Figures 1.1-4 and 1.1-5 show that the majority of the area in Sections 26 and 35 is designated as uncontaminated. However, the existence of large unlined and lined source basins have classified these uncontaminated areas as having a moderate percentage of contaminated area, therefore, a boring spacing of 750 ft was selected for all uncontaminated portions of these two sections.

The uncontaminated and background areas of Sections 26 and 35 contain several drainage ditches that could possibly contain contaminated soils. However, the boring spacing described previously does not adequately locate borings in these areas. Therefore, borings will be placed in the drainage ditches at a boring spacing of 2,000 ft. This boring spacing will provide sufficient analytical data to confirm that these areas are in fact uncontaminated.

All borings in uncontaminated areas will be constructed to 5 ft but only a single composite soil sample will be submitted for chemical analysis from each boring. Samples will be composited from sample intervals of 0-1.0 ft and 4.0-5.0 ft in line with sampling intervals discussed in Section 3.4. As with borings in specific sources these uncontaminated borings will be arranged in a regular grid pattern at locations shown in detail in Section 3.3.1.

The Phase I borings range in depth from 1.0 ft to the depth of the water table. The majority of the borings at each source will be shallow. A small percentage of the borings will be drilled to the water table which in some areas may be up to 40 ft deep. The deep borings will be located in areas where the contamination is expected to be deepest, generally near the source centers. A single deep boring may suffice for the small sources while the larger sources will require several deep borings. For all borings, depending on the designated depth, samples will be obtained from the following depths:

0.0-1.0 ft	19.0-20.0 ft
4.0-5.0 ft	29.0-30.0 ft
9.0-10.0 ft	39.0-40.0 ft
14.0-15.0 ft	

Task 6 results will provide a list of contaminants present in each source so that chemical analyses of Phase II samples can be individually tailored. Because the historical data regarding the types of contaminants present may be inaccurate or incomplete, all the Phase I soil samples will be scanned for a wide variety of analytes. Chemical analyses performed for all Phase I samples will include a semi-quantitative gas chromatography/mass spectrometry (GC/MS) scan for volatile and extractable organics and an inductively coupled argon plasma spectrophotometry (ICAP) scan for metals. In addition, these samples will be analyzed using quantitative methods for selected analytes which would not be detected by the above methods at the levels required. These methods include analyses for DCPD/BCHD, arsenic, and mercury. A summary of the Phase I Chemical Analysis Program appears in Section 4.0. Because historical data suggest that volatile organics may be present in the soil only at specific locations, all soil samples from sources thought to contain volatiles (35-3, 26-1, 26-3', 26-4', 26-5, and 26-6) will be analyzed by GC/MS for volatile organics. In locations where the presence of volatile organics is not expected only 10 percent of the soil samples will be analyzed for volatile organics. For all borings, except those located in Basin F, the samples collected from 0-1.0 ft will not be analyzed for volatile organics. Specific details concerning the Analytical Chemistry Program are presented in Section 4.0.

3.3.1 SOURCE CONDITIONS AND SOIL BORING PROGRAM

As discussed in Section 1.0 of this Technical Plan, Sections 26 and 35 at RMA contain numerous potential contaminant sources. Table 3.3-1 and Figures 1.1-4 and 1.1-5 summarize the status of the Task 6 investigation with respect to these potential sources. In the process of data review, additional areas suspected of containing contaminant sources were identified. During this review there was no evidence that surety material would be present in either of these sections. This portion of the Technical Plan presents source specific information including results

Table 3.3-1. Sections 26 and 35 Geotechnical Sampling Summary

Source	Source Activity	Areal Extent (ft^2)	Length (ft)	Spacing	Number of Borings	Number of Samples
26-1*	Deep Well Chemical Sewers	—	2,600	200	13	13
26-3'	Basin C	3,174,000	—	150	35	109
26-4'	Basin D	877,000	—	130	16	50
26-5	Basin E	1,280,000	—	140	16	47
26-6	Basin F	4,051,000	—	190	14	47
26-7	Basin B-C Drainage	—	300	500	1	5
26-9*	Chemical Sewer					
	(Continuation of 36-20,35-2)	—	3,300	500	7	7
26-U	Section 26 - Uncontaminated Area	20,000,000	—	750	36	36
	*Section 26 - Uncontaminated Ditches	—	4,200	2,000	2	2
35-2'*	Chemical Sewer					
	(Continuation of 36-20, 26-9)	—	6,700	500	13	13
35-3	Basin B	77,000	—	60	6	14
35-4'	Basin A-B-C Drainage	—	2,500	500	5	12
	*Additional Area		1,500	500	3	7
35-U	Section 35 - Uncontaminated Area	25,000,000	—	750	45	45
	*Section 35 - Uncontaminated Ditches	—	14,800	2,000	8	8
	TOTALS				220	429

* Investigation of these areas has been postponed by USATHAMA.

of previous geotechnical study, disposal history, contaminants present, numbers of Task 6 borings, anticipated numbers of samples, and shows tentative borehole locations on source maps. The number, depth, and exact locations of Task 6 borings may be altered as a result of field reconnaissance or detection of near surface metals.

3.3.1.1 Source 26-1: Deep Well Chemical Sewer

This source consists of all the chemical sewers that were used in conjunction with the deep well disposal. Specifically, this source consists of:

- o Two 8 in steel pipelines approximately 300 ft long. These pipes were used to transport waste from the northeast corner of Basin F to the deep well facility;
- o A 10 in vitrified clay pipe, 1,250 ft long that transported fluids from the southeast corner of Basin F to Building 802;
- o A 6 in high pressure steel pipeline about 250 long used to transfer liquid from the pump house to the well head; and
- o A 4 in steel pipeline 500 ft long that transferred the under flow from the clarifier back to Basin F.

Disposal History

Soon after Basin F was completed, it became obvious that the basin could not adequately handle the volume of wastes generated on RMA. As an alternative to Basin F, a deep well disposal facility was designed. The deep well disposal facilities were completed in January 1962 and were operated from March 1962 until February 1966. During this period an estimated 164 million gal of fluids were injected. Operation of the well was terminated due to a reported link between the injection of liquid waste and an increase in the frequency of earth tremors in the Denver area.

Contaminants

Since the material that was transported in these sewers originated in Basin F, the list of contaminants would also be identical to those listed for Basin F. In general, these would include any of the wastes from the manufacturing facilities located on RMA. Based upon analytical results

reported in August 1978 (Asselin and Hildebrandt, 1978), Basin F fluids may contain the following contaminants:

Aldrin	Endrin
Arsenic	Fluoride
Chloride	Iron
p-chlorophenylmethylsulfone	Isodrin
p-chlorophenylmethylsulfoxide	Magnesium
Copper	Mercury
Cyanide	Nitrogen
Dieldrin	Orthophosphate
Diisopropylmethylphosphonate	Sulfate
Dimethylmethylphosphonate	Total phosphorus

Hydrogeology

The deep well facility is located on a very gently sloping area in the north central part of Section 26. The area is underlain by approximately 50 ft of alluvium which is generally saturated. The water table is at depths ranging from 20 to 30 ft deep. The direction of regional ground water flow trends to the northwest.

Boring Program

The boring program for this source has been modified to decrease the boring spacing from 500 ft to 200 ft. This was done for the following reasons:

- The sewer lines were used to transport large volumes of waste liquids, and in some instances under pressure; and
- Experience has shown that sewers often leak at the pipe joints and in decreasing the spacing, the opportunity to sample more of the joints will exist.

The sewers are scheduled for removal at the same time field work for this investigation is proceeding. To prevent possible volatilization of contaminants, sampling will be performed immediately following removal of the sewer lines. Sampling points will be located on 200 ft centers and one sample will be obtained for each sampling point. Samples will be obtained from the 0-1 ft interval beneath the contaminated sewer. Also,

a geologist will be present during excavation operations to observe the condition of the pipeline and bedding materials. If any signs of pipeline deterioration, or obvious signs of leakage are detected, this location will be sampled as described previously. In addition, if obvious signs of contamination are noted in the trench sidewalls, samples will be obtained for analysis.

Based on a sampling spacing of 200 ft, a total length of 2,600 ft, a total of 13 sampling points are proposed. This number of sampling points will generate a total of 13 samples to be analyzed. A summary of the boring and sampling plan for this source is presented below:

Number of Borings	Depth (ft)	Number of Samples
13	varies from 4 to 6 ft	13

A tentative sampling location plan is presented in Figure 3.3-2.

3.3.1.2 Source 26-3': Basin C

Basin C (Figure 3.3-3) is an unlined basin located in the southeastern corner of Section 26. This source is approximately 73 acres in size and has been used to store overflow from Basin A. When Basin A reached its capacity excess liquids would flow northward via open drainage ditches to Basin B and eventually to Basin C. During repair of the Basin F liner, Basin C was used to store Basin F contents. Basin C has also been used to hold water from the Derby Lakes transported via the Sand Creek Lateral. The areal extent of contamination has been estimated at 3,174,000 ft^2 with an estimated total of 1,763,000 yd^3 of contaminated subsoils (RMACCPMT, 1984).

Disposal History

As with the other unlined basins of Section 26 Basin C was used to hold the overflow from Basins A and B. Aerial photographs indicate the presence of standing liquids in the northwest corner of the basin as early as 1948. By 1964 aerial photographs indicate that Basin C has been enlarged to its current size and that much of the basin displays signs of soil bleaching. In the same photograph two drainage ditches can be

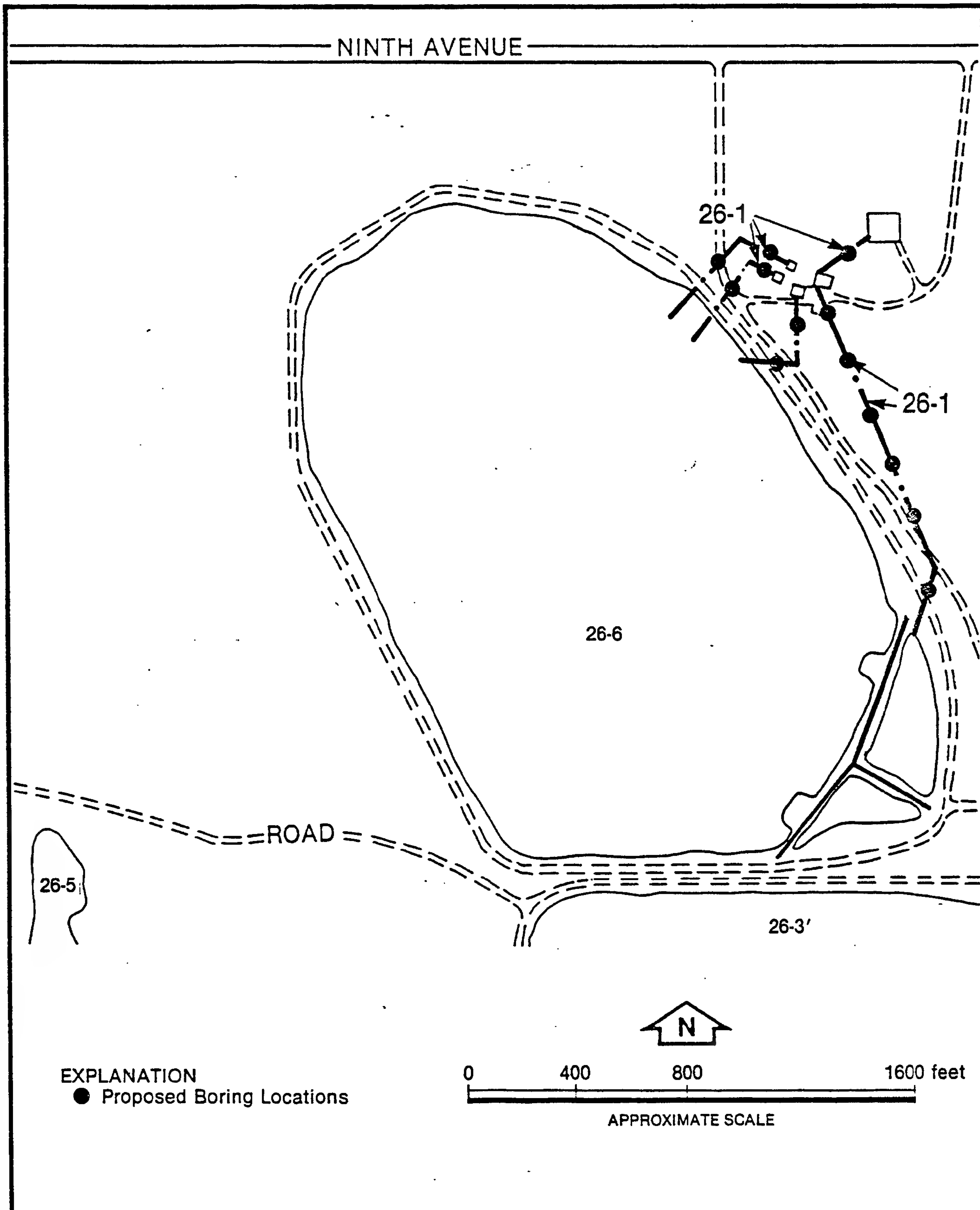


Figure 3.3-2
BORING LOCATION MAP
CONTAMINANT SOURCE 26-1
ROCKY MOUNTAIN ARSENAL, SECTION 26
SOURCE: HARDING LAWSON ASSOCIATES

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

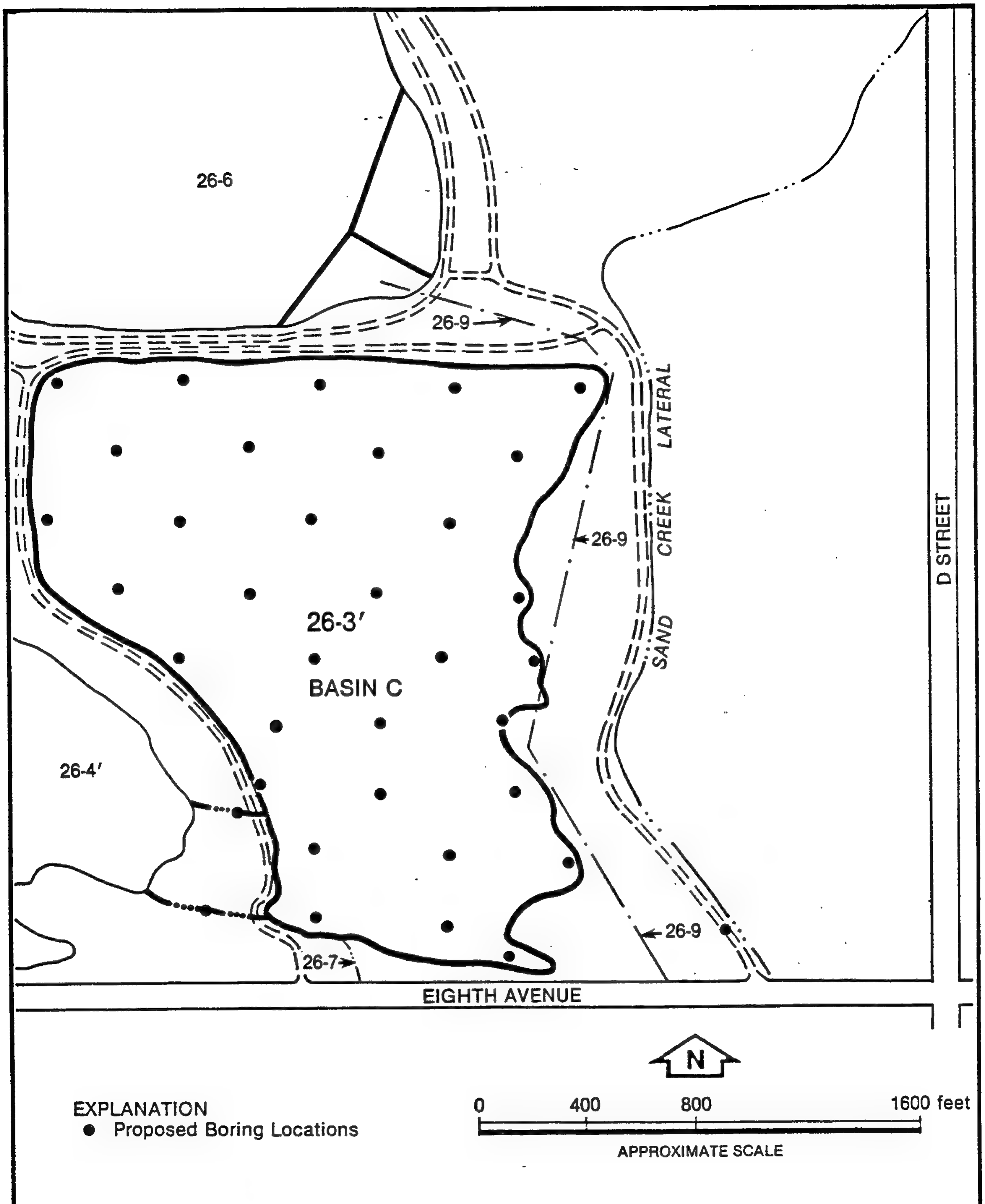


Figure 3.3-3
BORING LOCATION MAP
CONTAMINANT SOURCE 26-3′; BASIN C
ROCKY MOUNTAIN ARSENAL, SECTION 26
SOURCE: HARDING LAWSON ASSOCIATES

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

observed in the southwest corner of Basin C, that appear to drain into Basin D. The existence of these ditches has been verified by field reconnaissance and therefore they have been added to the Basin C source. At one point in Basin C history, the basin was used to store a portion of the contents of Basin F while its asphalt liner was being repaired.

By 1970, aerial photography indicates that Basin C is approximately 40 percent full and the remainder of the basin surface soils have been bleached white. The DAR* indicates that from 1968 or 1969 through 1974 Basin C was filled with fresh water resulting in the infiltration of about 1.0 cubic foot per second of fresh water. In a 1980 photograph, the basin appears relatively dry and presumably has stayed that way to date with the exception of ponded rainwater or snowmelt.

Contaminants

Basin C has received the overflow from Basin's A and B, and therefore, the liquids impounded in it would have a composition very similar to those stored in Basin A. These compounds would include but not be limited to:

Alcohols	DDE	Heptachlor
Aldrin	DDT	Mercury
Arsenic	Dieldrin	Organosulfur compounds
Chlordane	DIMP	Oxathiane
Chloride	Dithiane	Parathion
Chlorinated organics	Endrin	Sodium methyl phosphonate
DBCP	Fluoride	Sulfate
DCPD		

As part of the AEHA survey performed in 1973 soil samples were obtained and analyzed for various contaminants. The results of the survey indicate the presence of aldrin and dieldrin in the soil at concentration of 22 parts-per-billion (ppb) and 220 ppb respectively. Soil samples analyzed during the 1982 Geraghty and Miller Study indicated the presence of DIMP (0.005-0.87 ppm), CPMS (0.12 ppm), CPMSO (0.34 ppm), $CPMSO_2$ (408 ppm), copper (2.9-6.2 ppm), and arsenic (3.0-10.0 ppm) in the Basin C soils.

*DAR - Priviledged Litigation Information

Hydrogeology

Basin C is located over soils consisting mainly of silty or clayey sands that have moderate permeabilities. The alluvium in this area is relatively uniform and 25 to 30 ft thick. The alluvium is saturated only in the southwest portion of the basin. In all other areas the water table is below the alluvium/Denver Formation contact. The water table depth ranges from 20 (eastern half) to 30 (western half) ft below the bottom of the basin. Local ground water flow direction is to the west across Basin C.

Boring Program

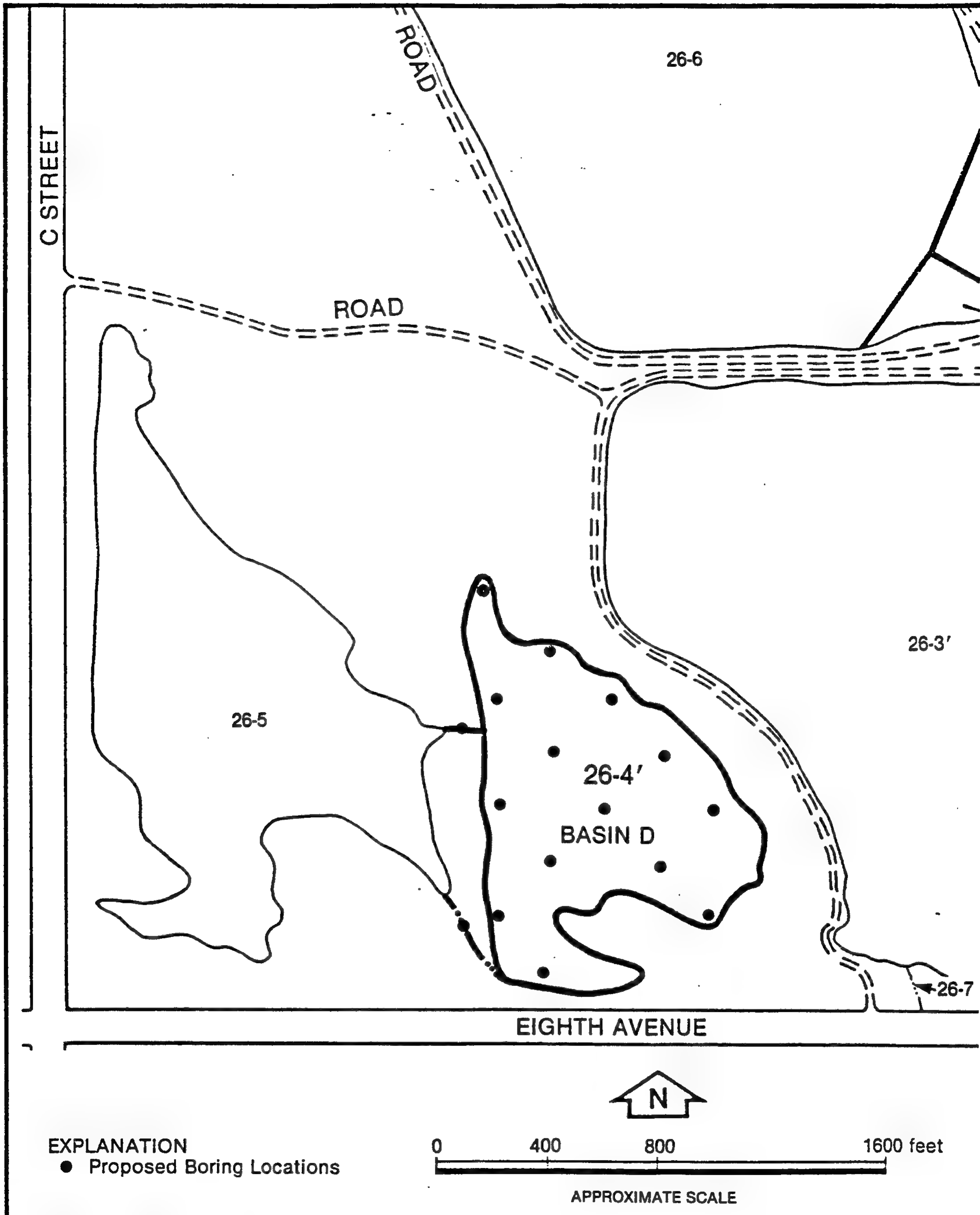
Based on an areal extent of 3,174,000 ft^2, a boring spacing of 150 ft was chosen resulting in a total of 35 Task 6 borings. Seven of these borings will penetrate to the water table with the remainder of the borings constructed to lesser depths. One boring will be located in each of the overflow channels leading to Basin D. The sampling program is summarized below:

Number of Borings	Depth (ft)	Samples
4	30 (WT, W)	24
3	20 (WT, E)	15
14	10	42
14	5	28

Approximate boring locations are shown in Figure 3.3-3.

3.3.1.3 Source 26-4': Basin D

Basin D is located immediately west of Basin C. The basin is a natural depression that was dammed to provide additional capacity. Basin D accepted the overflow of the liquids stored in Basin C with the amount of overflow determined by the position of the sluice gate located in the southwest corner of Basin C. A field reconnaissance of the area combined with review of historical aerial photographs lead to the discovery of two additional overflow drainage ditches located along the west boundary of Basin D that allows overflow into Basin E (see Figure 3.3-4).



Fiugre 3.3-4
BORING LOCATION MAP
CONTAMINANT SOURCE 26-4′; BASIN D
ROCKY MOUNTAIN ARSENAL, SECTION 26
SOURCE: HARDING LAWSON ASSOCIATES

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

Disposal History

Basin D has been used to hold overflow from the upgradient basins (Basins A, B, and C). As early as 1948 a significant area of standing liquid can be observed in aerial photographs. Approximately 20 percent of the basin is covered with liquid and the remainder of the basin bottom appears to have been recently disturbed (i.e., bleaching of basin soils). Also evident from the 1948 photograph is that the overflow from Basin B was flowing directly into Basin D. The direct flow into Basin D from Basin B is still noticeable in aerial photographs taken in 1964 and 1970. By 1970 the amount of fluids had increased to cover about 60 percent of the basin area. The liquid is separated into two pools, located in the northern and southern sections of the basin. By 1980, Basin D liquid levels have been reduced significantly, and occupy less than 10 percent of the basin. Field reconnaissance in June 1985 revealed the basin to be completely dry.

Contaminants

Basin D contained the overflow from Basins C and B and therefore the compositon of the fluid would have been similar. The types of contaminants that can be expected to be present in Basin D soils are the same as those from Basin C, (26-3'). The 1973 AEHA survey results indicated the presence of aldrin (310 ppb), dieldrin (15 ppb). The survey also states that Basin D is a major source of chloride pollution in ground water. The March 1976 Trost Report found Basin D to have high sulfate contents. The 1982 Geraghty and Miller Study indicated the presence of DIMP (0.1 ppm), $CPMSO_2$ (0.05 ppm), arsenic (0.079-4ppm), and copper (0.01-1.1 ppm) in Basin D soils.

Hydrogeology

Basin D is located in a natural depression which overlies approximately 25 to 30 ft of alluvium. The alluvium, except for the northernmost section of the basin, is saturated. The depth to ground water is approximately 30 ft. The direction of ground water flow in the vicinity of Basin D is to the west.

Boring Program

From the estimated areal extent of 877,000 ft^2 and Figure 3.3-1, a borehole spacing of 130 ft was selected which translates into a total of 16 Task 6 borings. One boring will be located in each of the drainage ditches that flow into Basin E and three borings will be constructed to the water table. The boring and sampling program is broken down as follows:

Number of Borings	Depth (ft)	Samples
3	30 (WT)	18
6	10	18
7	5	14

Figure 3.3-4 shows tentative boring locations. These locations are subject to change based on field conditions at the time of drilling.

3.3.1.4 Source 26-5: Basin E

Basin E is a natural depression that forms an unlined basin just west of Basin D. This source has been used in a simular fashion as Basins B, C, and D to hold overflow from Basin A. The basin has been dammed to increase capacity and currently covers an area of approximately 29 acres. Overflow from Basin D drains into Basin E via two weirs located in the west dike of Basin D. The amount of contaminated sediments in Basin E has been estimated at 711,000 yd^3 (RMACCPMT, 1984).

Disposal History

The disposal history of Basin E is very similar to that of Basins C and D in that it was used for the storage of liquids originating in Basin A. Review of historical aerial photographs reveal the following:

- Standing liquids were present as early as 1948 covering about 10 percent of the basin;
- By 1964, the basin had increased significantly in size, with much of the basin area showing signs of recent disturbance (i.e. bleaching of basin soils);
- The 1970 photograph indicates that Basin E is nearly full (90 percent) and the liquids are contained in two equally sized pools; and

- By 1980, all the fluids in Basin E have evaporated or infiltrated. Much of the area appears to have revegetated, although some bleached areas are still noticeable.

Contaminants

Due to the similarity of the materials contained in Basin D and E, the types of contaminants that could be found in Basin E are also similar to those in Basin D. The general types of contaminants that may be found in Basin E include those listed under contaminants for Basin C Source 26-3'. The results of the 1973 AEHA Survey indicate that Basin E soils contain aldrin (530 ppb), and trace concentrations of dieldrin. Basin E soils have also been shown to contain DIMP (0.05 ppm), CPMSO (0.481 ppm), $CPMSO_2$ (0.5 ppm), arsenic (0.0024-26 ppm), and copper (0.0062-7.1 ppm).

Hydrogeology

Basin E is located in a topographic low in the southwest corner of Section 26. This area is underlain by approximately 25 ft of alluvium. The alluvium is saturated under all but the northeastern edge of the basin. Depth to the ground water varies slightly but the average depth is about 20 ft. Ground water flow is to the west across the basin.

Boring Program

Based on an areal extent of 1,280,000 ft^2 a boring spacing of 140 ft was chosen resulting in a total of 16 borings to be completed in Task 6. A total of 3 borings will penetrate to the water table with the remaining 13 borings completed to shallower depths. The boring and sampling program is summarized below:

Number of Borings	Depth (ft)	Samples
3	20 (WT)	15
6	10	18
7	5	14

Proposed boring locations are shown in Figure 3.3-5.

3.3.1.5 Source 26-6: Basin F

Basin F is a 93 acre asphalt-lined reservoir with a holding capacity of 245,090,000 gallons (gal) that was constructed in late 1956 to handle all

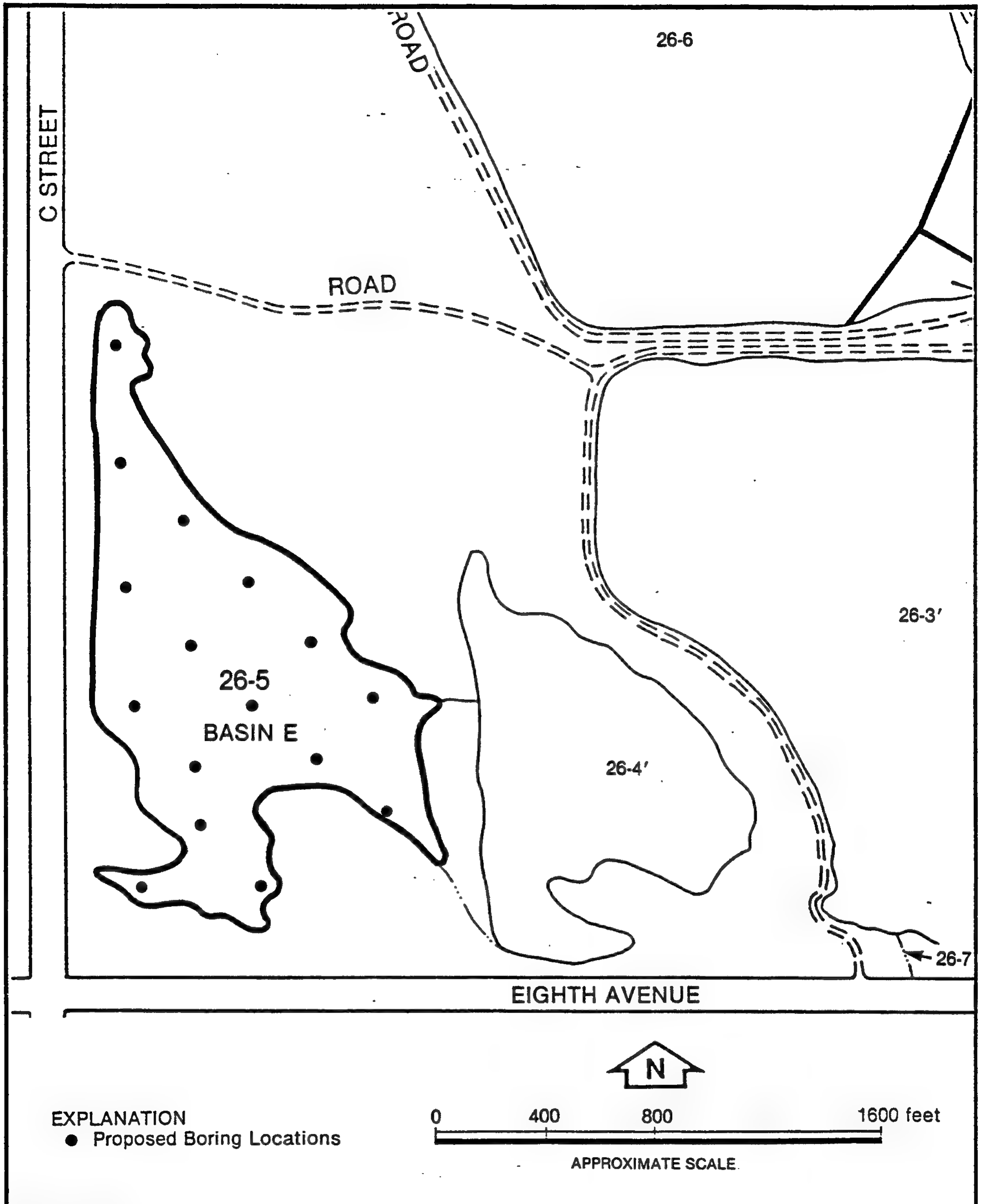


Figure 3.3-5
BORING LOCATION MAP
CONTAMINANT SOURCE 26-5′; BASIN E
ROCKY MOUNTAIN ARSENAL, SECTION 26
SOURCE: HARDING LAWSON ASSOCIATES

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

the industrial wastes and wastewaters generated on RMA. The basin was constructed in response to claims from farmers that the unlined basins at RMA (A, B, C, D, E) were causing ground water pollution and damaging their crops. The liner consisted of a 3/8 in thick asphaltic membrane sprayed over the prepared basin bottom. A 12 in layer of soil was placed over the liner to protect it from erosion and degradation due to sunlight.

Disposal History

Transfer of wastes from Basin A to Basin F began in December of 1956 with an estimated 60 million gal of liquid was to be transferred. The transfer operation continued until April 23, 1957, at which time the flow was stopped because the membrane liner in Basin F had developed a break at the water line. At this time the basin contained an estimated 105 million gal (approximately half full). Due to this break in the membrane lining, the contents above the break were pumped into the adjoining Basin C, lowering the contents of Basin F by 20 inches. The seal was repaired and rip-rap was placed on the banks to prevent further damage by wave action. By September 1957 the contents of existing contaminated basins were drained into Basin F.

Extended chemical sewer lines from the South Plants Area and GB facility carried effluent directly to Basin F.

By spring of 1960 the Basin F level had risen to 195 million gal (80 percent full). In 1962, a deep well disposal unit had been constructed for final disposal of filtered Basin F liquids, at which time the basin was approximately 90 percent full. The use of the deep well was discontinued in 1966. Aerial photographs taken in October of 1964 indicate that Basin F is near capacity. However, by 1966 the liquid level in Basin F was extremely low. Extensive areas of the bottom were exposed on the east and south sides and in several places the soil placed to protect the lining had eroded away. An examination revealed extensive breaks in the asphalt lining on the east side. The reported length of the ruptured membrane was approximately 100 ft running parallel to the shore. A more thorough survey was suggested to determine the exact

extent of the damage. It was also recommended that Basin F be maintained at a lower level to prevent further leakage into the aquifer. There is no record of repairs being made prior to September 1978, but it is known that the volume of chemical waste being pumped into Basin F increased significantly in later years and that the liquid level was above the rupture (Buhts, 1978).

Up through 1966, it was the practice of Shell Chemical Co. to dump semi-solid waste known as "still bottoms" into Basin F. This material would consist of organic compounds such as product precursors, side-reaction products, high-boiling solvents, etc. (Buhts, 1978).

Subsequent aerial photographs indicate the following:

- The entire basin is covered with liquid in April 1970; and
- Only 80 percent of the basin is covered by fluids as of September 1980.

All process discharge to Basin F ceased on December 31, 1981 and the influent chemical sewer line was removed as part of the baseline activities in 1982.

Field reconnaissance conducted in June of 1985 indicates the existence of two separate pools of liquid in Basin F covering approximately 40-50 percent of the basin bottom.

Contaminants

The disposal history of Basin F has been well documented and therefore the types of contaminants that can be expected are similarily documented. Numerous studies have been conducted to characterize Basin F fluids. The results of a 1978 study (Asselin and Hildebrandt, 1978) indicate that contaminants contained in Basin F fluids include but are not limited to:

Alcohols	DDT	Phosphorous
Chloride	DIMP	Sulfate
Chlorinated Organics	Fluoride	Sulfone
p-chlorophenylmethyl	Insecticides	
p-chlorophenylmethylsulfoxide	Metals	
DCPD	Pesticides	
DDE	Phenols	

The results of these studies also indicated that the liquids in Basin F are relatively homogeneous.

A study was performed by the U.S. Army Engineer Waterways Experiment Station (WES) personnel to evaluate the contaminant distribution in Basin F (WES, 1982). The study included development of sampling protocols for Basin F, leach testing and chemical analysis of numerous soil cores from the borings constructed below the liner in Basin F. The results of this study indicate the presence of the following contaminants in soils:

- Acetophenone
- Aldrin
- Arsenic
- p-chlorophenylmethylsulfone
- p-chlorophenylmethylsulfoxide
- DBCP
- Dithiane
- Dieldrin
- Diisopropylmethylphosphonate
- DIMP
- DMMP
- Endrin
- Fluoride
- Isodrin
- Mercury
- Metals
- Pentachloroethane
- Tetrachloroethylene
- Toluene
- Trichloroethane
- Xylene

Hydrogeology

Basin F was created in a natural depression of Section 26 and its capacity increased by construction of man-made dikes. Limited geotechnical information for soils near the location of cuts indicates the excavations extended into the upper soils thought to be relatively impervious. However, portions of the bottom of the basin may be set into the more pervious sediments associated with the alluvial aquifer. The alluvium is approximately 40 to 45 ft thick beneath the basin. The saturated alluvium thickness varies from 0 to 5 ft. The depth to ground water is about 30 ft in the southern half and 40 ft in the northern half. Ground water flow is generally north to northwest in the vicinity of Basin F.

Boring Program

Based on an areal extent of 4,051,000 ft^2, Figure 3.3-1 and the quantity of available existing contaminant information provided in the WES Study, a boring spacing of 190 ft was selected. The total number of borings for Basin F, Task 6 activities is 14, three of which will be constructed to the water table. The remainder of the borings will be drilled to lesser depths. In addition to samples obtained from the borings a sample of the asphalt liner will be obtained at each boring location. The liner samples will be retained for observation of the physical integrity of the liner. The sampling program is summarized as follows:

Number of Borings	Depth (ft)	Samples
2	40 (WT,N)	14
1	30 (WT,S)	6
5	10	15
6	5	12

Proposed boring locations are shown in Figure 3.3-6. These locations are subject to change based on field conditions.

3.3.1.6 Source 26-7: Basin B-C Drainage

This source is an open drainage ditch located south of Basin C and is a continuation of Source 35-4' located in Section 35. This ditch was used to transport significant quantities of liquids from Basin B to Basin C. This source is approximately 300 ft in length and the quantity of contamination has been estimated at 1,000 yds^3 (RMACCPMT, 1984).

Disposal History

Review of pertinent RMA documents indicate that this ditch was in use from 1943 to late 1957. Soon after the GB facility became operative, it became evident that Basin A did not have sufficient volume to handle the inflow of industrial waste and wastewaters. The overflow was transported to additional unlined Basins (B, C, D, and E) via open unlined drainage ditches. This source is a portion of the drainage ditch that transported the liquids from Basin B to Basin C. Review of aerial photographs indicate the presence of fluids in Basin B as late as 1975.

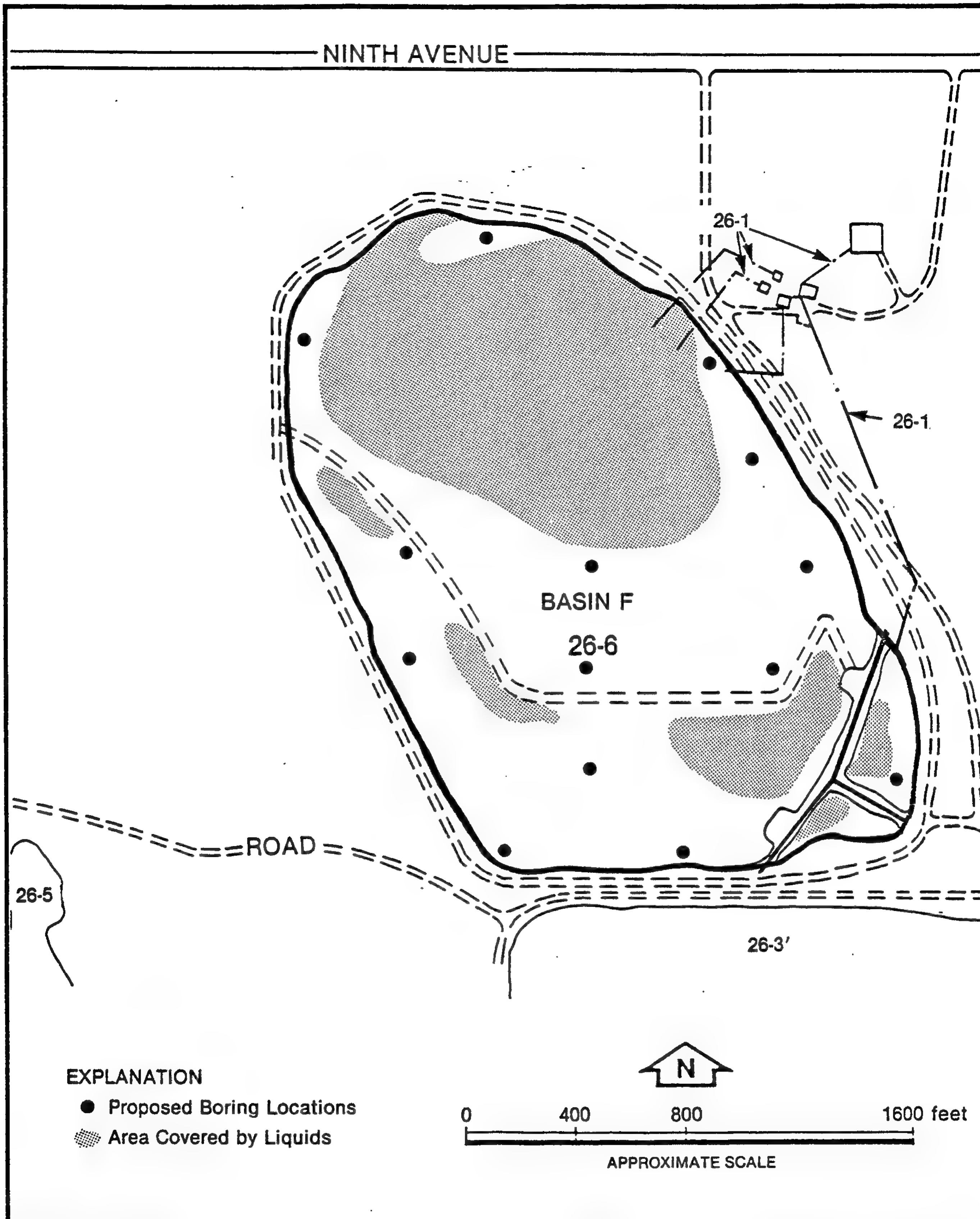


Figure 3.3-6 BORING LOCATION MAP CONTAMINANT SOURCE 26-6 ; BASIN F ROCKY MOUNTAIN ARSENAL, SECTION 26 SOURCE: HARDING LAWSON ASSOCIATES	**Prepared for:** **U.S. Army Toxic and Hazardous Materials Agency** **Aberdeen Proving Ground, Maryland**

Contaminants

As a transport mechanism for liquids initially stored in Basin A and Basin B. The possible list of contaminants for this source is essentially the same as for those basins. The list of possible contaminants for this source includes the following:

Alcohols	DCPD	Mercury
Aldrin	DDT	Organosulfur Compounds
Arsenic	Dieldrin	Oxathiane
Chlordane	DIMP	Parathion
Chloride	Dithiane	Sodium hydroxide
Chlorinated Organics	Endrin	Sodium methyl phosphonate
DBCP	Fluoride	Sulfate
DDE	Heptachlor	

Hydrogeology

Source 26-7 is located south of Basin C in an natural drainage depression. There is approximately 30 ft of alluvium beneath this source. The depth to the water table is about 20 to 25 ft. Ground water flow trends to the northwest.

Boring Program

This source has a very small linear extent (300 ft) and as such a boring spacing of 500 ft was selected yielding a single boring. This boring is designed to penetrate to the water table at a depth of about 20 ft. A total of five samples will be obtained. A proposed boring location is shown in Figure 3.3-7.

3.3.1.7 Source 26-9: Chemical Sewer

This source is the northern portion of the chemical sewer that was extended from the South Plants and GB facility to Basin F. The chemical sewer in Section 26 originated in the southeast corner and terminated at the southeast corner of Basin F. The chemical sewer was a continuation of the chemical sewer located in Section 35 (35-2') and was approximately 3,300 ft in length. The sewer was constructed of vitrified clay pipe.

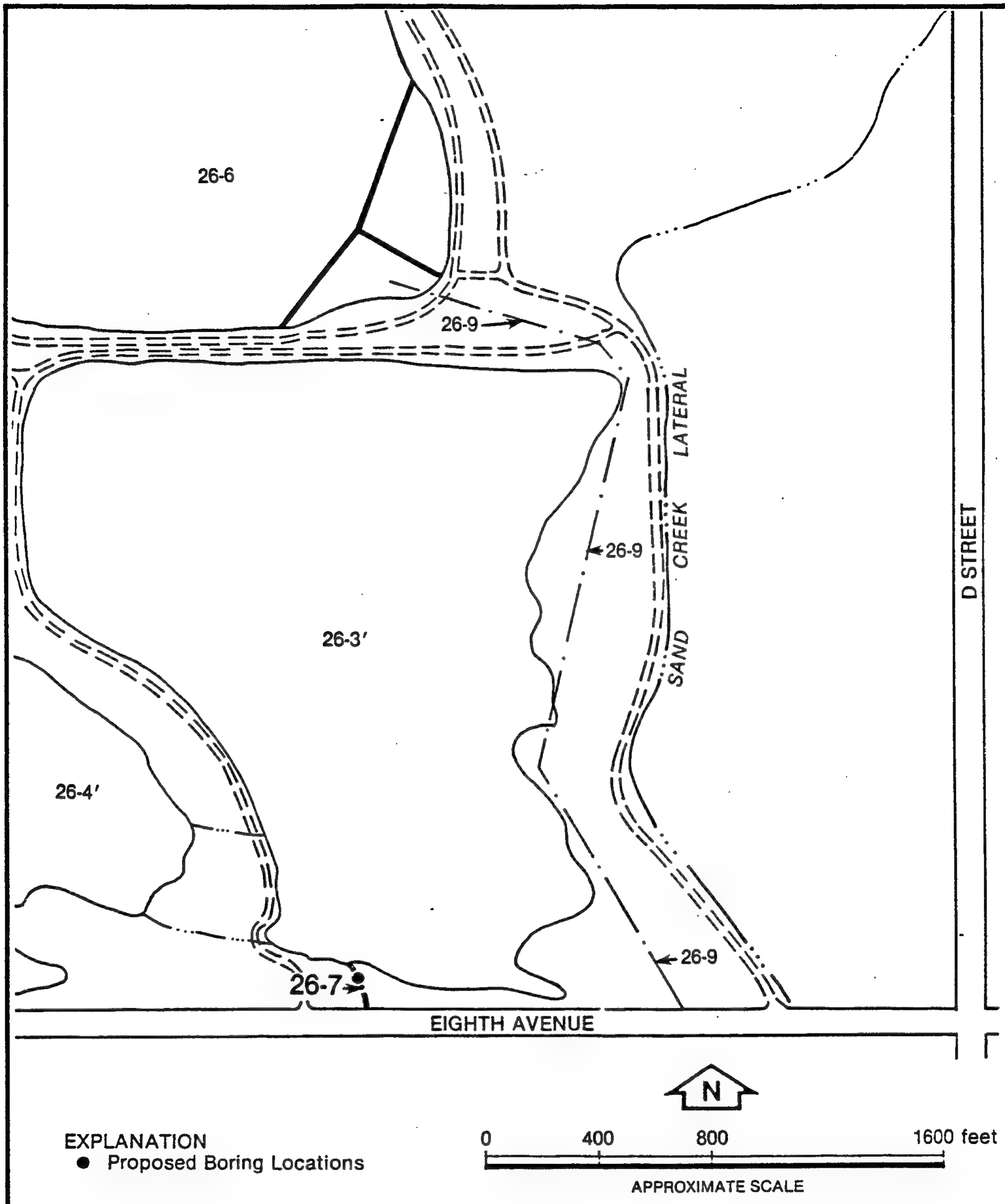


Figure 3.3-7
BORING LOCATION MAP
CONTAMINANT SOURCE 26-7
ROCKY MOUNTAIN ARSENAL, SECTION 26
SOURCE: HARDING LAWSON ASSOCIATES

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

Disposal History

The chemical sewer was used to transport all the industrial wastes and wastewaters generated by the South Plants manufacturing area and the GB facility to Basin F for disposal. Several surveys reported that the sewer had numerous leaks and therefore, as part of the baseline activities, this portion of the sewer was removed in 1982.

Contaminants

The soils beneath the leaking sewer line could have been exposed to a variety of contaminants originating in the South Plants or the GB facility, including heavy metals, pesticides, insecticides, organo sulfur compounds, alcohols, fluoride, chloride, phosphates and sulfates.

Hydrogeology

The chemical sewer alignment is located at the base of the topographic high in the southeastern corner of Section 26. Along its alignment, the alluvium varies in thickness from 35 to 40 ft and generally is not saturated. The water table (which is below the alluvium Denver contact) is at depths of 15 ft at the southern end, up to 30 ft at the northern end. Ground water flow generally flows to the west-northwest in the vicinity of the sewer line.

Boring Program

This source has a linear extent of approximately 3,300 ft and a higher probability of contamination. Therefore, a boring spacing of 500 ft has been chosen resulting in a total of 7 boreholes. Since the sewer line was removed in 1982 as part of the baseline activities, borings drilled as part of this task will penetrate and sample the bottom of the trench excavated during the removal process. This sampling program will provide sufficient information to evaluate if all of the contaminated subsoils were removed during the baseline activities. The sampling program is summarized below to the water table:

Number of Borings	Depth (ft)	Samples
7	varies from 4 to 6 ft	7

A tentative boring location plan is shown in Figure 3.3-8.

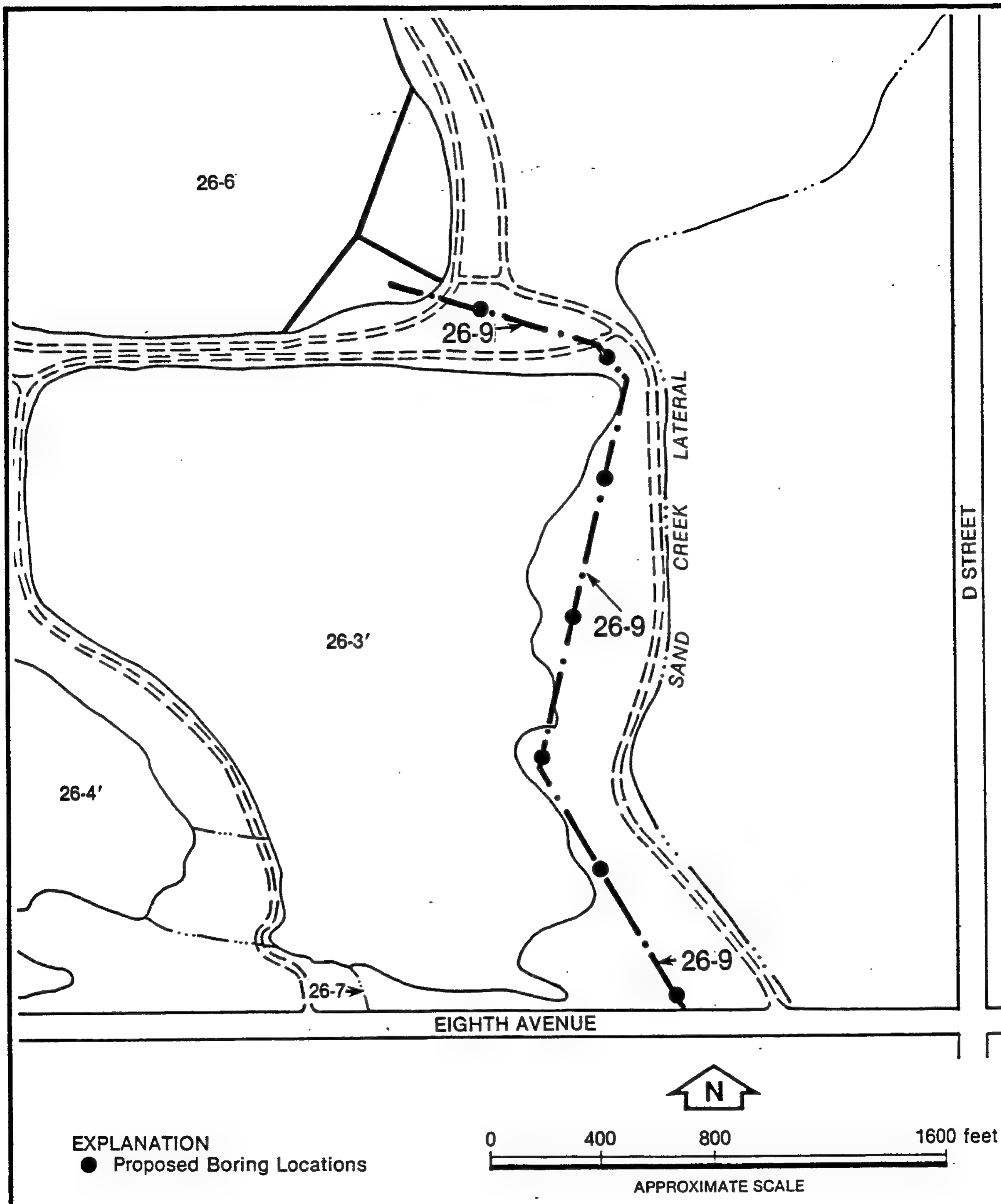


Figure 3.3-8
BORING LOCATION MAP
CONTAMINANT SOURCE 26-9
ROCKY MOUNTAIN ARSENAL, SECTION 26
SOURCE: HARDING LAWSON ASSOCIATES

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U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

3.3.1.8 Section 26 - Uncontaminated Areas

Significant portions of Section 26, not included in specific source boundaries, are considered to be uncontaminated. The total uncontaminated area of Section 26 has been estimated by USATHAMA to be 20,000,000 ft^2. Review of RMA contaminant maps and the RMACCPMT (1984) has indicated several sources have been downgraded to uncontaminated areas. These sources include 26-2 (TX Production Area) and 26-10 (TX Irrigation Pond). Table 1.1-1 lists potential contaminant sources that have been reclassified as uncontaminated for the purpose of this study.

An adequate number of borings will be drilled and samples obtained to confirm that the uncontaminated areas are indeed background areas that are free of significant contamination. Based on the presence of sources that may have introduced contamination into uncontaminated areas, the Section 26 uncontaminated areas are located in a section with a moderate number of contaminant sources. Therefore a boring spacing of 750 ft for the uncontaminated areas and spacing of 2,000 ft for uncontaminated ditches have been selected yielding a total of 38 borings. The borings will be arranged as shown in Figure 3.3-9. Uncontaminated borings will all be to depths of 5.0 ft.

The 5 ft cores from uncontaminated areas will be examined and logged to determine if visual subsurface disturbances have occurred at each borehole location. The geologist logging each core will look for evidence of disturbed horizons as well as for the presence of soil discoloration or debris.

For each 5 ft core a single composite soil sample will be analyzed. The composite soil will be prepared in the laboratory from the 0-1.0 and 4.0-5.0 ft designated sampling intervals. It is not anticipated that a Phase II boring program will be necessary in these areas.

3.3.1.9 Source 35-2': Chemical Sewer

This source is the northern extension of the chemical sewer (36-20') being studied as part of Task 1 activities. This portion of the chemical sewer begins as two separate lines in the southeast corner of Section 35

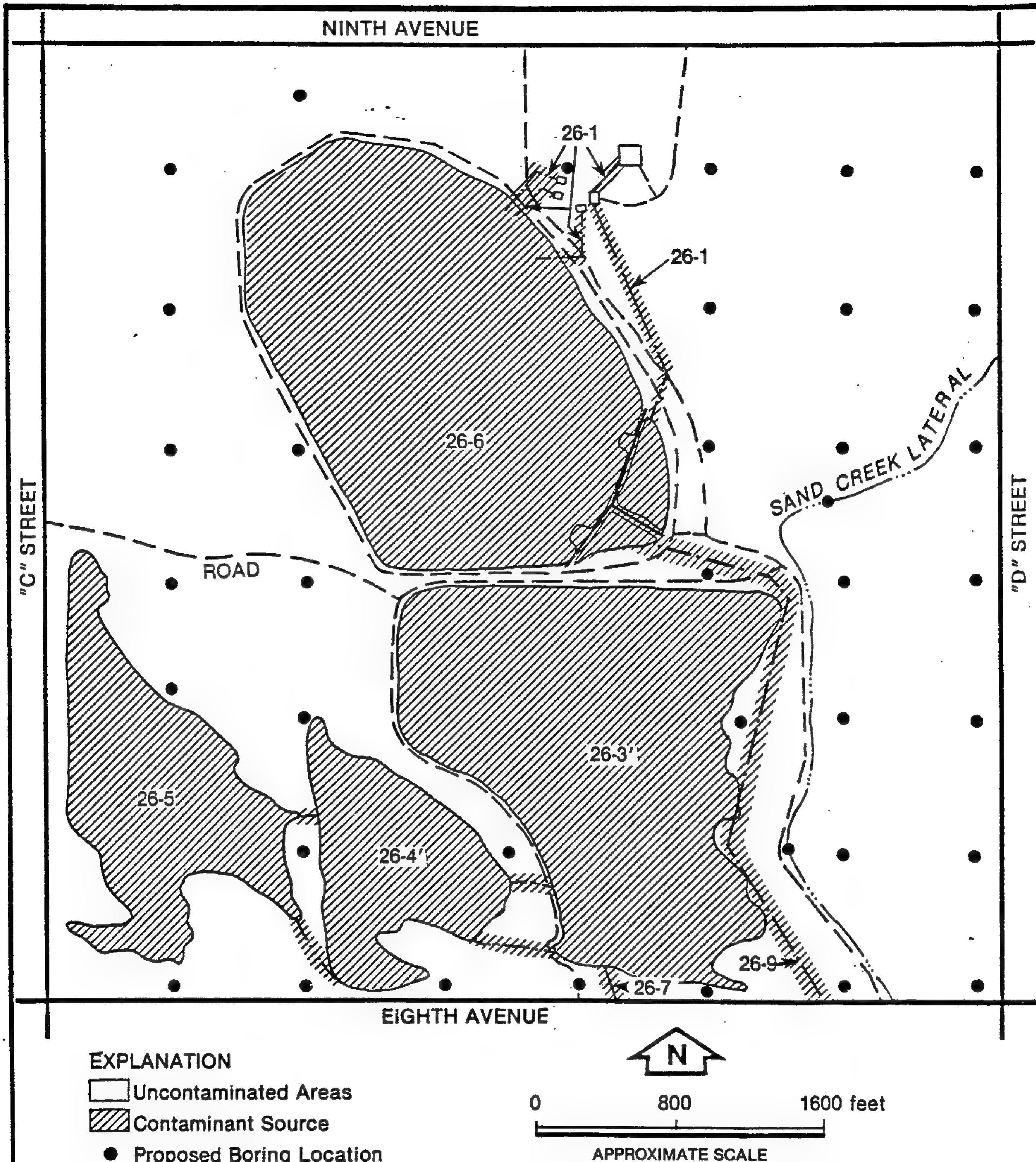

Figure 3.3-9 BORING LOCATION MAP SECTION 26 UNCONTAMINATED AREAS ROCKY MOUNTAIN ARSENAL SOURCE: HARDING LAWSON ASSOCIATES	**Prepared for:** **U.S. Army Toxic and Hazardous Materials Agency** **Aberdeen Proving Ground, Maryland**

(See Figure 3.3-10). The two lines converge at the eastern boundary then extend northward terminating at Basin F. This segment of the chemical sewer was removed as part of the baseline activities in 1982.

Disposal History

The chemical sewer was constructed using a vitrified clay pipe and was used to transport chemical wastes from the manufacturing areas to Basin F.

Contaminants

The chemical sewer line carried a variety of chemicals from the Shell manufacturing facilities including:

Aldrin	Dieldrin	Supona
Azodrin	Parathion	Vapona
DBCP	Planavin	

At its northern extent, the sewer line was also used to carry wastes and wastewaters from the GB plant to Basin F. The following is a list of probable contaminants discharged to the sewer line from the GB Plant:

- Hydrofloric Acid
- Isopropyl Alcohol
- Sodium Chloride
- Sodium Flouride
- Sodium Hydroxide
- Sodium Methylphosphonate

Several studies have revealed leaks along the chemical sewer line between the South Plants area and Basin F. Mixing of the chemical wastes with soils and ground water along the sewer alignment is likely, however, quantities and extent are unknown.

Hydrogeology

The chemical sewer runs adjacent to the eastern boundary of Section 35 where the thickness of alluvium varies in thickness from 25 to 40 ft. The alluvium is saturated along the majority of the sewer alignment with depth to the water table varying from 10 to 15 ft. The water table is at

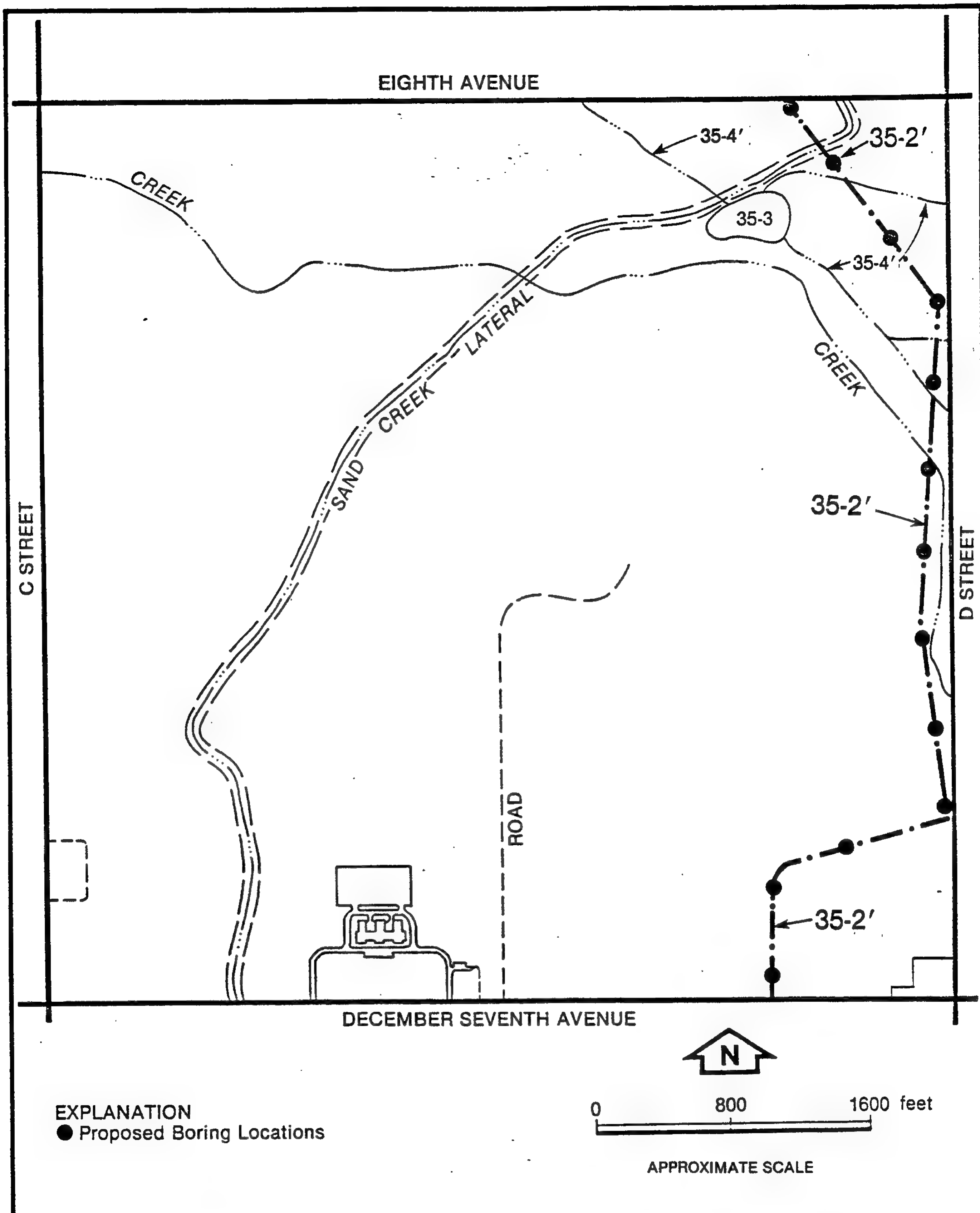

Figure 3.3-10
BORING LOCATION MAP
CONTAMINANT SOURCE 35-2′
ROCKY MOUNTAIN ARSENAL, SECTION 35
SOURCE: HARDING LAWSON ASSOCIATES

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

its deepest near the southeast corner of Section 35. Ground water flow across the sewer alignment is in a north-northwest direction.

Boring Program

Source 35-2' has an estimated linear extent of 6,700 ft and has a high probability of containing contaminated fluids. Based on this information a boring spacing of 500 ft has been selected resulting in a total of 13 boreholes to be constructed. The sewer line and a portion of the underlying soils were removed as part of the baseline activities in 1982. Therefore all borings constructed in this task will penetrate to the bottom of the trench excavated during the removal process and sample the next 1 ft interval. This will provide sufficient information to determine if all the contaminated subsoils were removed during the baseline activities. A total of 13 samples will be generated in accordance with the sampling program described below:

Number of Borings	Depth (ft)	Samples
13	varies from 4 to 6 ft	13

Boring locations are shown in Figure 3.3-10.

3.3.1.10 Source 35-3: Basin B

Basin B is located in the northeast corner of Section 35 (Figure 3.3-11). This unlined basin which is approximately 2 acres in area formerly held overflow from Basin A (Section 36). Liquid from Basin A flows through open chemical drainages (Source 35-4') into Basin B. During conditions where Basin B reached capacity, liquids drained toward the north along drainage Source 35-4' into Basin C. It has been estimated that the areal extent of Basin B is 77,000 ft^2 and that the volume of contaminated sediment is approximately 43,000 yd^3 (RMACCPMT, 1984).

Disposal History

At various times in Basin A history, liquid overflow was carried into and through Basin B on the way to Basins C, D, and E. Therefore liquids which were contained in Basin B would have had a chemical composition similar to that of Basin A liquids. Until 1957, Basin A was the primary receptor of waste liquids. Overflow entered Basin B. In a 1948 aerial

photograph, Basin B is not full but contains some liquid. In this photograph Basin A is close to full capacity. In a 1953 aerial photograph Basin A is less than half full and Basin B is dry.

In a 1958 photograph Basin B is full to capacity, but in 1962 this basin is less than 30 percent full. Use of Basin A was discontinued prior to 1958 and by 1962 much of the basin has revegetated. In 1970, Basin B is again full but by the 1975 aerial photograph is less than 10 percent full. By 1980, Basin B is completely dry and presumably had remained in this condition since 1980. In summary, Basin B has received liquids from Basin A and has contained these liquids at numerous times from 1948 to the present. Therefore soils in Basin B have been exposed to liquids which could have varied significantly in composition but similar to Basin A liquids.

Contaminants

As Basin B contained liquids derived from Basin A potential contaminants would include all those soluble compounds found in Basin A liquids. These compounds would include but not be limited to:

Alcohols	DDT	Mercury
Aldrin	Dieldrin	Organosulfur compounds
Arsenic	DIMP	Oxathiane
Chlordane	Dithiane	Parathion
Chloride	Endrin	Sodium methyl phosphonate
DCPD	Fluoride	Sulfate
DDE	Heptachlor	

Soil samples from Basin B were analyzed for a variety of these contaminants and at the levels of detection used were not found in significant concentrations. However, reportedly high concentrations of mercury (40 ppm) were observed in Basin B soils (Asselin, 1977). Soil samples taken in 1984 by Geraghty and Miller contained $CPMSO_2$ (.5 ppm).

Hydrogeology

Basin B is located above the bedrock channel that defines the Basin A neck. The alluvium is approximately 35 ft thick immediately beneath this

potential source. The alluvium is saturated and the depth to ground water is approximately 10 to 15 ft. The direction of ground water flow is to the northwest from the Basin A neck through Basin B to Basin C in both the alluvium and the upper Denver Formation.

Boring Program

Based on a areal extent of 77,000 ft^2 boring spacing for both Task 6 and Phase II was selected as 60 ft. This results in a total of 6 boreholes for the Task 6 boring program. A total of two borings will be constructed to the water table. The anticipated Phase I (Task 6) program is as follows:

Number of Borings	Depth (ft)	Samples
2	10 (WT)	6
4	5	8

Tentative borehole locations are shown in Figure 3.3-11.

3.3.1.10 Source 35-4': Basin A-B-C Drainage

Source 35-4' (Figure 3.3-12) is an open chemical drainage ditch which was used to transport overflow from Basin A to Basin B and from Basin B to Basin C. The two portions of Source 35-4' are unlined and carried large quantities of Basin A liquids. The combined length of Source 35-4' is approximately 4,000 ft. The estimated areal extent is 12,600 ft^2 and the estimated volume of contaminated soil is 5,000 yd^3 (RMACCPMT, 1984).

Disposal History

This open chemical drainage was used to transmit liquid overflow from Basin A to Basin B, C, D, and E over a period in excess of thirty years. Therefore the volumes of liquids which flowed through this source are uncertain and the composition of these fluids variable.

Until 1957 Basin A was the primary receptor of all waste liquids. Aerial photographs show that during the period from 1948 until 1958 Basin B contained varying quantities of liquid. These photographs indicate that Basins C, D, and E contain various volumes of liquid. Therefore, these large volumes of liquids were all transmitted through Source 35-4'. In aerial photographs from 1958 to present the use of Basin A was

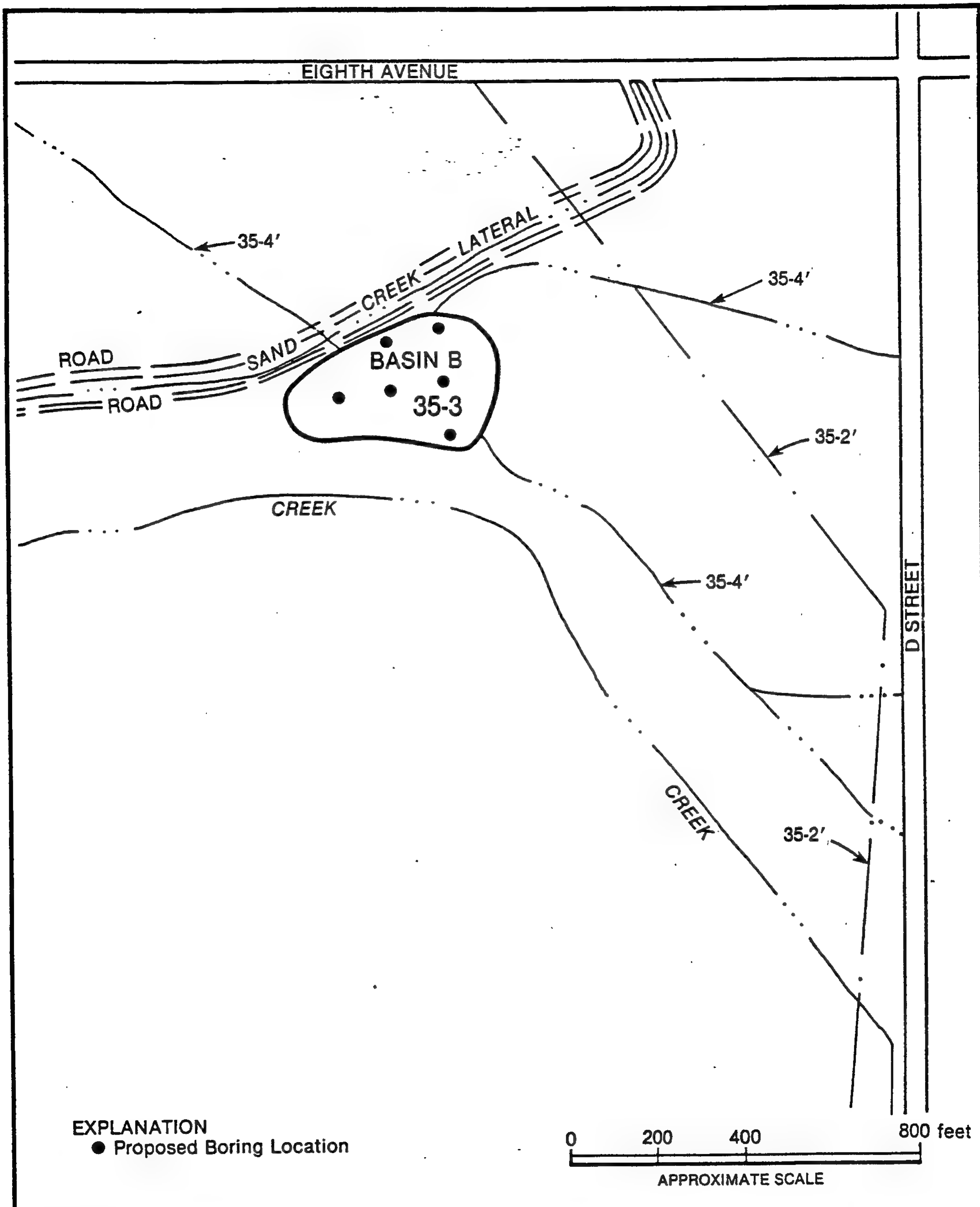

Figure 3.3-11
BORING LOCATION MAP
CONTAMINANT SOURCE 35-3 ; BASIN B
ROCKY MOUNTAIN ARSENAL, SECTION 35
SOURCE: HARDING LAWSON ASSOCIATES

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
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discontinued but liquids are still observable in Basin B until 1975 where Basin B is observed to be almost totally dry.

Contaminants

Liquids transmitted through Source 35-4' were identical in composition to those liquids present in Basin B. Potential contaminants include:

Alcohols	DDE	Mercury
Aldrin	DDT	Organosulfur compounds
Arsenic	Dieldrin	Oxathiane
Chlordane	DIMP	Parathion
Chloride	Dithiane	Sodium hydroxide
Chlorinated organics	Endrin	Sodium methyl phosphonate
DBCP	Fluoride	Sulfate
DCPD	Heptachlor	

Hydrogeology

Source 35-4' (open chemical drainage) is situated over the bedrock channel which connects Basin A with Basins C through E. The alluvium varies in thickness from 30 to 40 ft and is saturated. Ground water is present at depths of 10 to 15 ft.

Ground water flow in this area trends to the northwest in both the alluvium and upper Denver Formation.

Boring Program

The boring program for Source 35-4' was designed based on an estimated length of 4,000 ft. This source is considered to have a high probability of containing contaminated soils and therefore a boring spacing of 500 ft was selected for the investigation in Section 35. The 8 borings to be completed will be constructed to the following depths:

Number of Borings	Depth (ft)	Samples
3	10 (WT)	9
5	5	10

Tentative borehole locations are shown on Figure 3.3-12. These locations may be altered as a result of additional field reconnaissance.

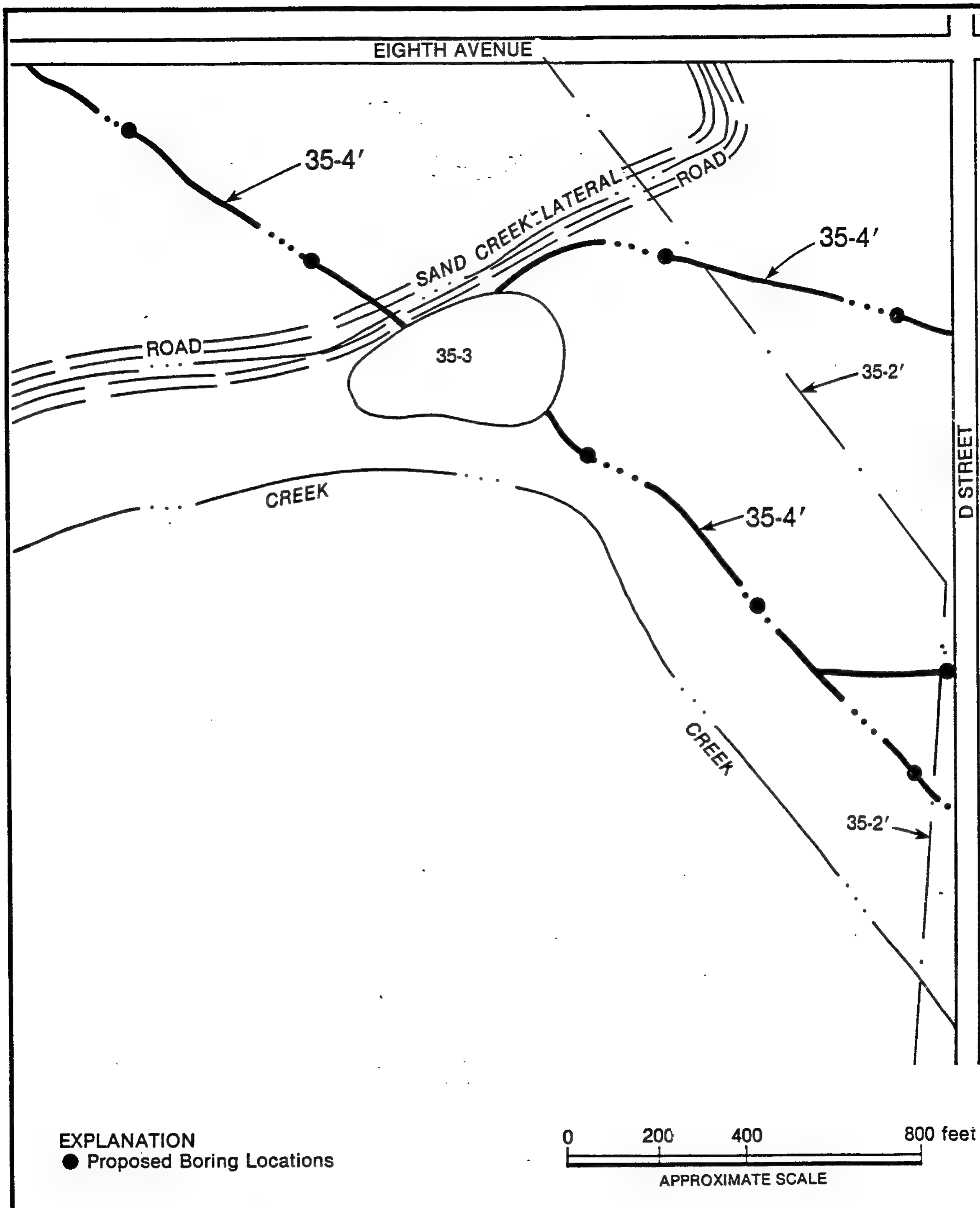

Figure 3.3-12 BORING LOCATION MAP CONTAMINANT SOURCE 35-4′ ROCKY MOUNTAIN ARSENAL, SECTION 35 SOURCE: HARDING LAWSON ASSOCIATES	**Prepared for:** **U.S. Army Toxic and Hazardous Materials Agency** **Aberdeen Proving Ground, Maryland**

3.3.1.12 Section 35: Uncontaminated Areas

The majority of the total area of Section 35 is not included within designated source boundaries and is considered to be uncontaminated. USATHAMA estimates the total uncontaminated area of Section 35 to be 25,000,000 ft^2. Interpretation of aerial photographs and RMA contaminant source maps have resulted in identification of surficial disturbances and ground scars that are not identified contaminant sources. Table 1.1-1 lists potential contaminant sources within Section 35 that preliminary investigations have classified as uncontaminated areas. These areas include Sources 35-5 (Ground Disturbances), 35-8 (Air Force Storage Area), and 35-9 (Caustic Holding Pond).

In order to confirm that the uncontaminated portions of Section 35, shown in Figure 3.3-13, are in fact uncontaminated or free of significant contamination soil boring and sampling will be performed. Section 35 contains a moderate number of contaminant sources that may have introduced contaminant compounds into uncontaminated areas. Therefore uncontaminated borings will all be to depths of 5.0 ft at boring spacing of 750 ft for uncontaminated areas and 2,000 ft spacing for uncontaminated ditches. Boreholes will be arranged in a regular grid pattern as shown in Figure 3.3-13. A total of 53 boreholes are to be constructed in uncontaminated areas of Section 35.

The 5 ft cores from uncontaminated areas will be examined and logged to determine if visual subsurface disturbances have occurred at each borehole location. The geologist logging each core will look for evidence of disturbed horizons as well as for the presence of soil discoloration or debris.

For each 5 ft core a single composite soil sample will be analyzed. The composite soil will be prepared in the laboratory from the 0-1.0 and 4.0-5.0 ft designated sampling intervals. It is not anticipated that a Phase II boring program will be necessary in these areas.

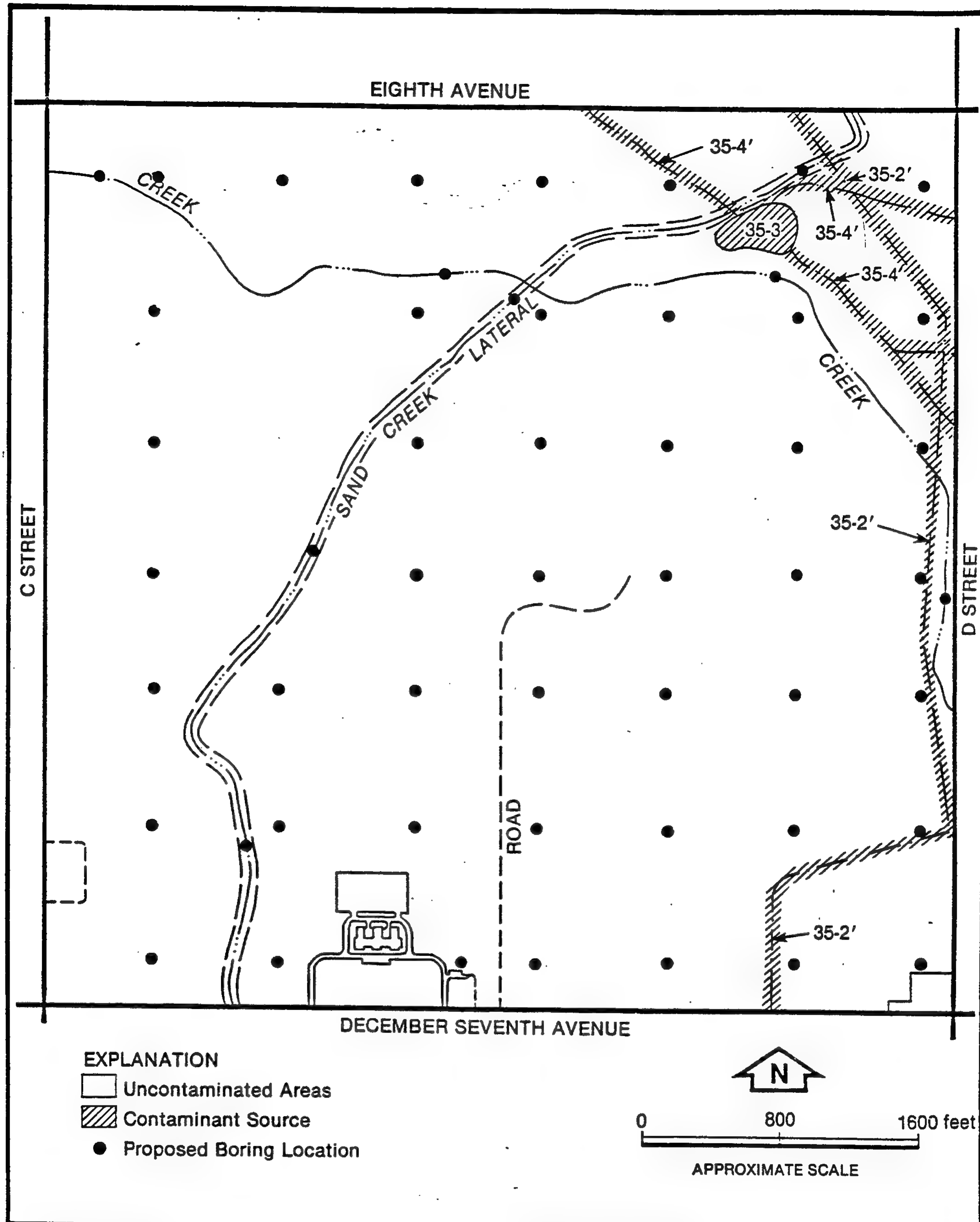

Figure 3.3-13
BORING LOCATION MAP
SECTION 35 UNCONTAMINATED AREAS
ROCKY MOUNTAIN ARSENAL
SOURCE: HARDING LAWSON ASSOCIATES

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

3.4 SOIL SAMPLING

All test borings will be constructed and sampled using a continuous core augering technique. This technique has been successfully utilized for many geotechnical investigations. With this technique the entire length of the boring will be examined and locations of contacts will be more precisely determined than if standard split-spoon sampling were executed.

The continuous coring technique will obtain 5 ft length cores within clear plastic "polybutyrate" liners. Although specific sampling intervals have been predetermined, the method of obtaining soil core in polybutyrate tubes will allow the addition of samples to the Chemical Analysis Program from horizons of visually observable contamination in addition to regular sampling intervals. Field measurement of volatile organics using an HNU instrument will also be used to assess the presence of contamination during coring and therefore additional sampling intervals as appropriate. The sample cores will not be logged at the boring site. Logging of the soils and sampling of soils for chemical analysis will be done at the support facility in the sample handling trailer. This procedure will minimize the risk of contamination of the samples from wind-blown particles or precipitation. A detailed description of the sample handling procedure can be found in Section 3.4.2.

Once the samples for chemical analysis are obtained, the cores will be resealed and stored. Therefore, the cores will be available if additional core interpretation is deemed necessary, but further chemical analyses may not be possible if sample holding times are exceeded.

3.4.1 DRILLING TECHNIQUES

All boreholes will be drilled using an all-terrain vehicle mounted drill rig equipped with hollow-stem augers and capable of continuous-core sampling. If conditions prohibit the rig from constructing shallow borings in areas of soft ground, these borings will be cored by hand. Both techniques are described in later sections. All drilling equipment, including the rig, water tanks, augers, drill rods, samplers, etc., will be steam-cleaned prior to arrival at the site. Between boreholes all

downhole equipment will be steam-cleaned, using COR-approved water. All sampling equipment will also be cleaned prior to use. Decontamination and cleaning procedures are described in Section 7.0.

Prior to drilling, a test boring location will have been numbered and staked, and as appropriate, buried metal objects will be located using geophysical methods described in Section 3.2. Borings will be sampled continuously from the ground surface down to a predetermined depth or the water table. The total depth of a boring may be adjusted in the field. If the water table is encountered before the predetermined depth, the test boring will be immediately terminated.

Air emissions from the test borings will be monitored during the drilling operations using either an organic vapor analyzer (OVA) or a photoionization detector (PID).

The borings will be logged stratigraphically by examination of the continuous cores. The data will be recorded on boring log forms and will include, but not be limited to, boring number and location, date, drilling equipment, driller's name, method of sampling, and soil descriptions. Soils will be classified according to the Unified Soil Classification System. Original boring logs will be submitted to USATHAMA upon completion of the boring.

After the boring is complete and the augers have been removed, the cuttings from the boring will be spread out onto the nearby ground surface. A small board will be placed over the boring until it is abandoned by grouting later the same day. The stake containing the boring location numbers will be firmly placed in the ground next to the boring until the boring is grouted when the stake will be placed in the grout.

3.4.1.1 <u>Continuous Core Augering</u>

It is anticipated that all soil sampling will be performed using an all-terrain vehicle mounted hollow stem auger drill rig with continuous coring capabilities. The continuous coring method advances the 5 ft long

core barrel with the augers and undisturbed soil samples are collected in clear polybutyrate core tubes. The polybutyrate tubes will be precut in lengths to obtain samples from intervals discussed below and placed in the core barrel for a maximum core length of 5 ft. This sample collection method is anticipated to be utilized for all soil sampling with the possible exception of locations close to ponded water where soils may be extremely soft. Whether all borehole locations will be accessible to the rig and how many locations may not be accessible will be determined primarily by weather conditions at the time of sampling.

For purposes of program estimation boreholes have been designated to be constructed to depths from 1.0 ft to 40.0 ft. for Sections 26 and 35. Pre-determined depth intervals are designated for sampling. These depths are:

0.0-1.0 ft	19.0-20.0 ft
4.0-5.0 ft	29.0-30.0 ft
9.0-10.0 ft	39.0-40.0 ft
14.0-15.0 ft	

Although the depth of the deepest boreholes at each source will be governed by the depth to the water table, these sampling intervals will be adherred to. As stated previously, deepest boreholes at each source will be constructed to the water table.

The need to sample specific depth intervals, the desire for simplicity in core logging, and laboratory requirements for sample collection necessitate the preparation of polybutyrate core tube prior to drilling. The team laboratories require a 1 ft section of core be removed from the core length be sealed, and remain sealed during shipment to the laboratory. Therefore, 1 ft sections of polybutyrate will be pre-cut and placed in the core barrel in positions appropriate to the sampling intervals listed above. Once the core barrel has been removed from the borehole and opened these pre-cut sections will be removed, sealed with Teflon® film lined plastic caps, and transported to the support facility for shipment. Upon arrival at the laboratory the sample will be subcored with a cork-borer apparatus to obtain a soil sample which has not been in

contact with polybutyrate. This procedure will minimize potential compatibility problems of soils and polybutyrate and reduce the chance of organic compounds being contributed to the soil sample from the core tube.

The remaining polybutyrate core tube, not designated for sample collection, will be placed in the core barrel after being etched longitudinally so that the cut can be completed in the sample handling trailer. Such a longitudinal cut, providing a split core tube, will allow efficient sample logging without the need for extrusion of the core from the tube. These longitudinally cut core sections will be removed from the core barrel at the borehole, taped and capped to hold them shut, and examined by the rig geologist to adjust the depth of borehole construction, if necessary. The taped core sections will be transported to the support facility. In the sample logging trailer these cores will be opened, logged, additional samples removed if appropriate, retaped, and sent to the core storage area.

The procedures for drilling and continuous coring are as follows:

1. Set up rig at staked and cleared borehole location;
2. Record location, date, time and other pertinent information on boring log form;
3. Place polybutyrate core tubes cut to specification into core barrel;
4. Commence augering and coring according to the following sequence: 0-1 ft, 1-4 ft, 4-5 ft, 5-9 ft and 9-10 ft, etc. Each predetermined sampling interval is cored in 1 ft sections to insure acceptable sample recovery;
5. At the completion of each coring interval, the core barrel will be removed from the borehole and opened;
6. When appropriate the 12 in sections for laboratory analysis will be removed, capped with Teflon® film lined plastic caps and sealed with tape, and immediately placed in a cooler;
7. Core sections previously etched length wise will be taped and sealed with plastic caps to prevent opening during transport to the support facility;

8. The polybutyrate liner sections will be marked with an arrow pointing to the top end, the boring number, and depth interval. A label giving the same information as well as the project name and number, the date, and the samplers initials will be attached to the core in the sample handling trailer;
9. For each additional 5 ft depth increment to be cored, clean polybutyrate liners will be placed in a clean core barrel;
10. The boring is considered complete when the predetermined depth is reached or the drilling encounters the water table, whichever comes first. For trench disposal areas the coring will be performed to the maximum depth of observable contamination;
11. All core sections will be transported to the support facility for logging and sample shipment preparation;
12. The boring stake will be left in the ground adjacent to the borehole and a board placed over the hole until it has been grouted;
13. All boreholes greater than 1 ft in depth will be grouted the same day of construction and the borehole location stake be placed in the grout. One foot deep borings will be backfilled with native materials available adjacent to the boring, and the borehole location stake planted firmly in the backfill;
14. Upon completion of each boring, the augers and other downhole equipment will be decontaminated in the field prior to moving to the next borehole location. When all borings in a specific source have been completed the drill rig will be initially cleaned at the source location. Upon completion of the initial cleaning the drill rig will be transported to the decontamination pad where it will be thoroughly steam-cleaned before entering another source area;
15. Enough augers and core barrels will be available such that one set may be in use while a second set is being decontaminated;
16. At the end of the working day all equipment, except the drill rig, and personnel will proceed to the decontamination pad where decontamination procedures will be initiated. Decontamination procedures are described in Section 7.0.

In addition to the procedures listed above, borings drilled in Basin F require supplemental set-up proceudres. These additional procedures are needed to insure that when drilling through the liner and its overburden, no liquids or waste materials escape into the borehole. WES personnel developed these additional proceudres when conducting their investigation of Basin F. Those procedures have been modified to meet the needs of the Task 6 investigation and are summarized in the next paragraph.

Overburden will be removed from an area approximately 2 ft in diameter using shovels. Extreme care is exercised so as not to disturb the liner. Clean cloth rags will be used to wipe the surface of the liner. A 1 ft diameter, steel caisson will be placed in the hole and bentonite will be poured around the outside of the bottom of the caisson. Outside of the caisson will be backfilled to approximately 0.3 ft with overburden material. The overburden and bentonite will be mixed with a shovel in order to effect a seal between the liner and the bottom of the caisson. Overburden is then backfilled around the caisson to the original surface elevation. At this point, site preparation is complete. Basin F borings will be abandoned by grouting the borehole and the steel caisson to the surface of the overburden with a cement/bentonite grout.

Shell has indicated that they would like to obtain split samples from the soil cores obtained during field investigation. The following procedures will be utilized to provide Shell with the requested sample:

- o A list of all requested samples approved by the COR will be provided to the field team geologist by USATHAMA;
- o Upon receiving the approved list, the geologist will coordinate with a representative of Shell as to an acceptable time for sample splitting;
- o The geologist will obtain all the desired smaples from the core storage building and bring them to the loading dock and present them to the Shell respresentative;
- o Shell representative will be required to repackage the cores back to their previous condition; and
- o The ESE geologist will return the cores back to their proper location in the storage building.

3.4.1.2 Hand Cored Sampling

An alternative sampling method may be necessary to construct the shallow boreholes where the ground surface is so soft as to be inaccessible to the drill rig. These areas are most likely located in areas where the water table is very close to the ground surface, and borehole depths will probably be limited to 1 or 2 ft. A description of this method follows.

In areas inaccessible to the drill rig, continuous cores will be obtained by pushing or driving a 1 ft section of polybutryate liner into the ground. A piece of Teflon® film and plywood will be placed over the top of the polybutryate tube and the tube will be pushed or driven into the ground by hand. The tube will be removed from the ground by shovel, the tube exterior wiped clean, the ends capped with Teflon® film lined plastic caps, and sealed with tape.

For soil samples collected in Basin F, the asphalt liner and overlying sand will be removed prior to sampling. A portion of the asphalt liner will be obtained and saved to document the liner condition. Sampling will commence at the base of the asphalt liner material. Following sampling the disturbed area will be resealed with grout.

The sample tubes will be marked with the boring number, the depth interval sampled and the upward direction. A label will be taped to the outside of the core. This label will include the same information written on the sample tube, as well as the project name and number, the date and the sampler's initials. Labels will be used in accordance with the procedures established in Section 6.0 (Data Management Plan) of Task 1 Technical Plan.

The cores will be logged and stored in a cooler with commercially available Blue Ice prior to and during transport to the support facility sample handling area where they will be logged and prepared for shipment.

3.4.2 SAMPLE LOGGING AND HANDLING

After each test boring is completed, the cores will be taken to the support facility sampling logging area to be logged and samples prepared

for shipment. The cores will be placed on clean plastic sheets and examined, in order, from the surface sample downward. Descriptions of the soil and other observations will be recorded on boring logs as established in Section 3.4.1.

The cores will be examined for visible indications of contaminants. If these are present, additional soil samples will be obtained from these intervals in addition to samples from pre-determined depth intervals. If there are no visible contaminants or if the visible contamination occurs throughout the core, samples from regular depth intervals, collected in 12 in core tube section will be sent to the team laboratories.
If additional depth increments are designated for sampling and analysis then the depth increment to be sampled will be cut from the core using clean stainless steel instruments and placed in amber glass jars sealed with Teflon®-lined lids. The sample jar will be marked with the boring number, and depth interval. Also, a label with the boring number, depth interval, date, project name, number, and samplers initials will be affixed to the jar.

All samples designated for analysis of volatile organics will come from regular depth intervals, as sealing in the 12 in pre-cut core tube will minimize evaporation of volatiles. The laboratory will sub-core these samples and perform the methanol dispersion method for volatiles. No samples from 0-1.0 ft or additional depth increments will be submitted for analysis of volatile organics except from beneath the Basin F liner.

The depth increments sampled will be recorded on the boring logs. The samples will be labelled with the boring number, depth interval, date, project name and number, and sampler's initials. All field data for these samples will be recorded. The samples will be stored at 4°C in ice-filled coolers or in a refrigerator.

3.4.3 CHAIN-OF-CUSTODY

Chain-of-custody forms will be completed and will accompany the samples. The data on the forms will include the boring number, the depth interval, date sampled, project name and number and signatures of those in

possession of the samples. A description of chain-of-custody protocol is included in Section 5.0.

3.4.4 SAMPLE SHIPMENT

Samples will be shipped daily by air freight to the project laboratories. The 1 ft polybutyrate tubes will be sealed in plastic bags and placed in cardboard tubes. Each cardboard tube will be labeled with the boring number and sample interval. The cardboard tubes will be placed in a plastic bag and shipped in heavy duty coolers filled with ice in sealed plastic bags. The sample jars will be wrapped in bubble wrap, placed in plastic bags, and shipped in heavy-duty coolers filled with ice in sealed plastic bags. Corresponding chain-of-custody forms will be placed in water proof bags and also put into the coolers. Details on sample shipment are found in the Quality Assurance Plan portion of this document.

3.4.5 CORE STORAGE

After the samples have been removed from the cores, the cores will be taped shut and the ends sealed with plastic caps which are also taped. The labels should be checked and reattached. The cores will be stored in core boxes in Building 728, located in the South Plants Area.

3.4.6 BORING ABANDONMENT

Each soil boring greater than 1 ft in depth will be sealed by grouting on the day in which the boring was completed. Borings 1 ft in depth will be backfilled with native soils. The grout will be composed of 20 parts cement to 1 part bentonite with enough water (COR-approved) for a pumpable mixture. For the deep borings, greater than 20 ft, the grout will be pumped through a tremie pipe placed at the bottom of the boring. The grout will be pumped until undiluted grout flows to the grout surface. For the shallower borings the grout will be poured in from the ground surface. Before the grout cures, the borehole location stake will be set into the grout. This stake will be painted fluorescent orange and labeled with the boring location number. Grout settlement will be inspected after 24 hours and depressions will be filled with additional grout of approved composition. For investigations in Basin F, any

sampling area where the asphalt liner has been disturbed will be sealed to maintain liner integrity.

3.4.7 SURVEYING

The boring locations and ground-surface elevations of borings will be surveyed by a Colorado registered surveyor as drilling proceeds. For each boring, the boring number, corresponding map coordinates and elevation, and date of measurement will be recorded in the field logbook. The data will be transmitted to USATHAMA upon completion of the surveying.

3.5 SUPPORT FACILITIES

The following onsite facilities which have been constructed for Task 1 will be utilized for Task 6.

1. Decontamination facilities;
2. Onsite offices;
3. Sample logging and handling facilities;
4. Equipment storage building; and
5. Storage building for soil cores.

Onsite offices consist of a trailer divided into several offices. A separate trailer will be used for logging and sampling of cores as well as processing of samples for shipment. Soil cores are to be stored in Building 728. Support facilities utilize a third trailer for showering of personnel and cleaning of small field equipment. The shower trailer will be arranged such that one end of the trailer is for entrance and the other is for exit of personnel from field activities and will be considered "dirty". This end of the trailer will contain changing areas and lockers. The other end of the trailer will contain lockers for street clothes with showers midway between the "dirty" and "clean" portions of the trailer.

Decontamination of large equipment such as bulldozers for drill rig and trucks as well as personnel decontamination will occur at the decontamination pad located adjacent to Basin F in Section 26. The decontamination pad is a concrete structure which drains into a

collection sump. Decontamination water will be disposed of as described in the Task 1 Technical Plan.

Final decontamination of large equipment such as bulldozers or drill rigs will be performed on the 20 x 30 ft concrete pad in Section 36. The concrete pad is constructed to drain into a sump from which water will be placed in 2,500 gal polyethylene tank to be temporarily retained onsite. These waters will be chemically analyzed and if acceptable, discharged to the RMA sanitary sewer system. The concrete disposal pad will have a gravel road leading to it to avoid creating muddy conditions during equipment decontamination operations.

The support facilities located across 7th Avenue from the decontamination pad in Section 1 will include a trailer designated as a site office equipped with sanitary facilities, as well as telephone, water, and electrical hookup. Waters from the showers and sanitary facilities will be discharged to the RMA sanitary sewer system. Details of criteria for disposing of waters to the RMA sanitary sewer system will be determined upon consultation with RMA and USATHAMA personnel.

A thorough description of support facility activities including decontamination procedures and schematic layout of the support facility area are found in Section 7.0.

In addition to these initial site activities, a nearby water source will be located and secured. This water will be used for all field activities, including grouting and equipment decontamination. The water will be sampled, analyzed, and approved by the COR prior to initiation of geotechnical work. This water will be free of chlorination and be analyzed for all EPA priority pollutants. Criteria for water characterization will be finalized upon consultation with USATHAMA and RMA personnel.

4.0 CHEMICAL ANALYSIS PROGRAM

The objective of the chemical analysis program is to provide reliable, statistically sound and legally defensible analytical data for soil samples and provide information on the types and levels of contamination at selected sampling locations. During this phase each sample will be screened utilizing semi-quantitative GC/MS techniques, inductively coupled argon plasma (ICAP) emission spectioscopy, atomic absorption (AA) and gas chromatography (GC).

The list of contaminants of concern is the same as that used in Task 1 and can be seen in Table 4.1-1. All the methods that will be used are the same ones previously tested during the Task 1 lab certification process.

The sample handling and preparation techniques will be the same as used previously in Task 1. The one ft sections of soil sent to the lab will be subsampled with a stainless steel coring tube through the center of the core cased in polybutyrate. Samples taken for volatile analyses will be quickly placed into VOA bottles containing preweighed solvent. Non-volatile analytical samples will be mixed thoroughly on the dull side of aluminum foil then transferred to amber bottles with Teflon®-lined lids for storage prior to sample workup. Holding times are those used for Task 1 as are the quality control techniques of X and R charts.

Table 4.1-1. Contaminants for Phase I of Concern at RMA
(Page 1 of 2)

Organic Contaminants

Ethylbenzene
Benzene
Aldrin
Endrin
Dieldrin
Isodrin
Dibromochloropropane (DBCP)
Malathion
Parathion
Methylisobutylketone (MIBK)
Chlorophenylmethylsulfide (CPM Sulfide)
Chlorophenylmethylsulfoxide (CPM Sulfoxide)
Chlorophenylmethylsulfone (CPM Sulfone)
Dicylcopentadiene (DCPD)
Hexachlorocyclopentadiene (HCCPD)
Chlordane
Supona
Bicycloheptadiene (BCHD)
p,p'-DDT
p,p'-DDE
Atrazine
Dimethyldisulfide (DMDS)
Vapona

Table 4.1-1. Contaminants for Phase I of Concern at RMA (Continued, Page 2 of 2)

Organic Contaminants (Continued)
Chloroform
Diisopropylmethylphosphonate (DIMP)
Dimethylmethylphosphonate (DMMP)
Dithiane
1,4-Oxathiane
1,1-Dichloroethane
1,2-Dichloroethane
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Carbon tetrachloride
Methylene chloride
trans-1,2-dichloroethylene
Toluene
Xylenes (o-, m-, p-)
Chlorobenzene
Tetrachloroethylene
Trichloroethylene
Inorganic Contaminants
Zinc (Zn)
Copper (Cu)
Chromium (Cr)
Cadmium (Cd)
Lead (Pb)
Arsenic (As)
Mercury (Hg)

Source: ESE, 1984.

5.0 QUALITY ASSURANCE

The Quality Assurance (QA) program for Task 6 is the same program defined in Chapter 5 and Appendix B of the Technical Plan for Task 1 (DAAK11-84-0016).

Field sampling QA audits will be conducted on sample handling, field documentation and sample shipment. Laboratory sample handling and analytical techniques will be identical to those used in Task 1. The quality of data will be monitored through the use of $\bar{X}$ and R charts.

All Quality Control (QC) charts, raw data and other formatted data will be reviewed and validated by QA prior to release of the data to Level 2 in the data management system. QC charts and negative reports will be forwarded with comments on a weekly schedule to USATHAMA.

6.0 DATA MANAGEMENT PLAN

Data for Task 6 will be handled according to the Data Management Plan in Volume I of the Task I Technical Plan Contract Number DAAK11-84-0016. As outlined in the plan, field data (i.e., map files, ground water stabilized field and field drilling files) will be entered into the Compaq Plus personnel computer in the ESE Denver office and transmitted to the Compaq in the ESE Gainesville office via telephone. The field data will be transferred to the IR-DMS, put through the Geotest data check routine, validated, and put in Level 2. Sample number assignments, labels, and logsheets will be made in Gainesville and given to the sampling team. Samples shipped to MRI and ESE will follow chain-of-custody procedures described in the Technical Plan for Task 1. Data from lab analyses will be entered into the ESE Prime 750 computer, incorporated with certification and field data, and formatted into field according to the IR-DMS User's Guide. After validation these files will be sent to the Univac using the Tetronix or the Compaq Plus computer, run through the data-checking routine and elevated to Level 2. MRI will transfer validated chemical data using software developed by ESE for remote laboratories (Technical Plan, Task I, Volume II, Appendix C). Using the same procedure as for ESE data, MRI data will be put in Level 2 in the IR-DMS.

7.0 SAFETY PROGRAM

7.1 EXECUTIVE SUMMARY

The safety program for Task 6 has the same objective as that of Task 1; that all operating procedures will ensure the safety of ESE and subcontracting personnel performing activities related to the site investigations at RMA. The program addresses all of the requirements of DI-A-5239B and fully complies with requirements of the Occupational Safety and Health Act (OSHA). The program also complies with U.S. Army Material Development and Readiness Command (DARCOM) Regulation 385-100, Army Regulation (AR) 385-10, and Department of Army Pamphlet (DA PAM) 385-1 for all activities to be conducted. The program also complies with the ESE Analytical Laboratory Safety Plan.

In general, the safety program for Task 1 meets the safety requirements for Task 6. All responsibilities and authorities of personnel remain the same. Safety training and medical examinations are required for all personnel involved in field activities in Sections 35 and 26. Air monitoring, accident prevention, communications, levels of personal protection, decontamination procedures, work zone delineation, contingency plans, and general site procedures will remain virtually the same as those in Task 1 with some variations. These variations are described below.

7.2 VARIATIONS FROM TASK 1 SAFETY PROGRAM

7.2.1 WORK ZONE DELINEATION

The site layout for Sections 26 and 35 can be seen in Figure 7.2-1. The hotline extends around the entire boundary of Section 26 except for a small area adjacent to the deep well area. This area, the contamination reduction corridor, will contain a decontamination pad for both vehicle and personal decontamination.

A contractor, hired by the Army, will be performing activities to close down the deep well and surrounding facilities. Work zone delineation will be coordinated with the closure contractor when sampling activities take the field team into the deep well area. Frequent communication will

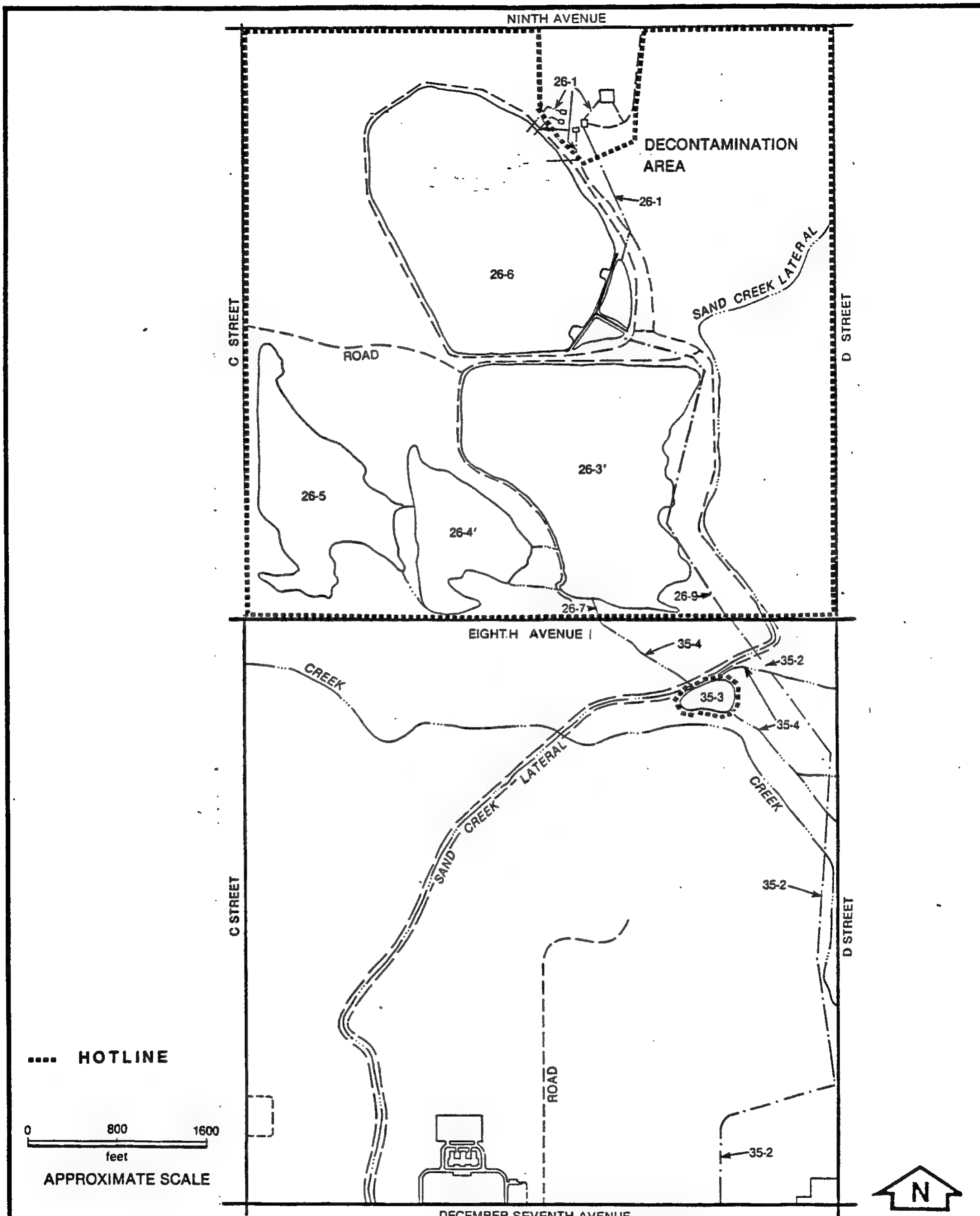

Figure 7.2-1
GENERAL SITE LAYOUT

REVISION A, 8/9/85

Prepared for:
U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland

take place between the field team and closure contractor to avoid hampering either field teams' activities. It may be necessary to modify the hotline on a daily basis when the two field teams are in proximity to one another. The OSO will discuss modifications with the closure contractor's safety personnel prior to making the modifications. All modifications will be clearly marked in the field and team members will be informed of the changes.

The hotline will be marked with rope and orange flagging tape for Source 35-3 because of ill-defined boundaries. Other sources within this section are canals and ditches and as such are clearly distinguishable. The remaining source is the area where the chemical sewer was excavated. The only hazard here will be 5-7 ft underground and will pose no immediate danger. Areas outside these hot zones are considered uncontaminated.

There will be no contamination reduction corridor in Section 35. The decontamination pad in Section 26 will be used following activities in Section 35. Because the road between Sections 35 and 26 is a clean area, plastic sheeting will be laid out across the road when vehicles and personnel need to cross to Section 26. This will prevent the road from becoming contaminated. After all vehicles cross the road, the plastic will be disposed of as hazardous.

7.2.2 LEVELS OF PROTECTION

All activities within hot zones will require the same personal protection as prescribed in the Task 1 Safety Program. Activities in the uncontaminated areas of Sections 26 and 35 will be completed in Level D protection. This protection includes normal work clothing with hardhats, steel toe-steel shank rubber boots, and rubber gloves. Respirators will be readily available. If above background concentrations of organics are indicated on the HNU the Onsite Safety Officer (OSO) will immediately stop work and upgrade to modified Level D protection. Modified Level D protection will be worn in all uncontaminated areas of Section 26. Modified Level D includes all items for Level C except respirators are

ready but not worn. Level C protection will be worn within 30 ft of an open borehole when drilling in source areas on both sections.

Because there is no historical or physical evidence of agent contamination in Sections 26 or 35, no continuous agent monitoring will be done. However, when readings on the HNU or other organic vapor detectors are found within the breathing zone, precautionary measures will be directed by the OSO.

Odors from Basin F have been noted in the past as very offensive. Field team members will attempt to shift activities to remain upwind of Basin F. If this is not possible, respirators will be worn if there is an obvious odor emanating from Basin F. Background HNU readings will be taken to determine levels of respiratory protection for drilling in and around Basin F.

The field team members will be required to sample a trench following the removal of a sewer line in Section 26 by another contractor. The exact depth and width of this trench is not known at this time. However, sampling activities will be coordinated with the removal contractor. When sampling the sewer trench, it may be necessary for personnel to enter it. However, attempts will be made to sample the trench without entering it. If it is necessary to enter the trench, personnel will enter the enclosed space in Level B protection. A Self-contained Breathing Apparatus will be used as the air supply. OSHA regulations for shoring the trench will be followed. Shoring techniques will be designed after gathering further information from the removal contractor.

7.2.3 DECONTAMINATION PROCEDURES

No decontamination will be necessary in the uncontaminated areas of Section 35 unless contaminated soils are indicated through the use of the HNU. Decontamination is required for all other areas of Sections 26 and 35. Until a decontamination pad is constructed in Section 26, contaminated vehicles and personnel will cross the road on plastic to Section 36. Vehicles will then drive on the inside shoulder of the road on Section 36 to the decontamination pad on the south side of Section 36.

Once on the pad, Task 1 decontamination procedures will be followed. When the decontamination pad is completed in Section 26, Task 1 decontamination procedures will be followed. Water used for decontamination will be collected in a sump and pumped into barrels for proper disposal.

During drilling activities in contaminated areas of Section 35, decontamination will take place on the pad in Section 26. Plastic will be placed on the clean road to prevent the spread of contamination when contaminated vehicles and personnel cross to Section 26.

Samples will be shuttled to the road during activities in Section 26 and source areas of Section 35. This procedure will allow the vehicle and driver transporting samples to the logging trailer to stay in the clean zone. The vehicle and driver will not have to be decontaminated each time a sample comes from the field.

Coolers in which samples are placed will be kept in plastic bags to prevent contaminating the coolers. These bags will then be disposed of as hazardous waste.

8.0 CONTAMINATION ASSESSMENT

The data collected during the Sections 26 and 35 investigation will be integrated with existing site background information to assess as far as possible:

- o The type of contamination and an estimate of the extent and depth;
- o The degree of hazard presented by the contamination;
- o The probably cause of contamination;
- o The local geologic and hydrologic conditions; and
- o The contaminant fate and transport of migration potential.

With the information obtained from this Phase I approach, the Damage Assessment Report for Sections 26 and 35 will be updated and each site will be described in as much detail as can be concluded from this semiquantitative chemical data and limited geologic and hydrologic data. From the sampling scheme in this phase, identification of the presence or absence of Shell chemicals can be made. Geochemical data will be compiled by source, location, and depth to the extent possible.

In conjunction with the above a proposed technical approach for the Phase II sampling will be prepared and will use two sampling schemes. Condition A, where significant number of sample points are found to be chemically uncontaminated, will use interpolating procedure, kriging, to position the Phase II points. Condition B in which all points or all but one or two are contaminated will require sampling to be performed outward from the site in order to identify the boundaries separating the contaminated from uncontaminated soils. Position this way is necessary because kriging cannot be used for extrapolation. The approach used for each condition is defined in Chapter 8 of the Technical Plan for Task 1.

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